



Initial Application for an Alternate Liner Demonstration

**Belle River Power Plant
Diversion Basin Coal Combustion
Residuals Unit**

November 2020

Prepared For:

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Executive Summary

TRC, on behalf of DTE Electric Company (DTE Electric), has prepared this Initial Application for an Alternate Liner Demonstration pursuant to the XX, XX, 2020 Hazardous and Solid Waste Management System: Disposal of Coal Combustion Residuals From Electric Utilities; A Holistic Approach to Closure Part B: Alternate Demonstration for Unlined Surface Impoundments (40 CFR § 257.71(d)) (Part B Rule) for the Belle River Plant Diversion Basin (BRPP DB) Coal Combustion Residuals (CCR) Unit.

This application and its attachments demonstrate how DTE Electric qualifies for and should be granted the opportunity to complete and submit an Alternate Liner Demonstration per 40 CFR § 257.71(d)(1)(i) for approval as continued operation of the BRPP DB CCR Unit would pose no reasonable probability of adverse effects to human health or the environment in the future based on the following:

- Compliance with all provisions of the Final Rule: Disposal of CCR from Electric Utilities (CCR Rule); April 15, 2015, 40 CFR part 257 subpart D, including a sufficient groundwater monitoring network under § 257.91;
- The groundwater monitoring program meets the requirements of § 257.93 and § 257.94, and per analytical data collected as part of the program, remains in detection monitoring;
- The presence of a natural geologic barrier (more than 80 feet of native clay-rich soil) that provides the equivalent, or better level of protection from potential migration of contaminants than a composite liner defined in 40 CFR § 257.70(b);
- Sufficient documentation that the unit meets all the location restrictions under § 257.60 through § 257.64, and;
- The BRPP DB CCR Unit is not located adjacent to a surface water body.

1.0 Regulatory Framework and Site Background

Regulatory Framework - On April 17, 2015, the U.S. EPA issued the Final Rule: Disposal of CCR from Electric Utilities (CCR Rule), 40 CFR 257, Subpart D, to regulate the disposal of CCR materials generated at coal-fired units. The rule is being administered under Subtitle D of the Resource Conservation and Recovery Act (RCRA, 42 U.S.C. § 6901 et seq.). On XXXX XX, 2020, the EPA Administrator issued revisions to the CCR Rule that required all unlined surface impoundments to initiate closure by April 11, 2021, unless an alternative deadline is requested and approved (40 CFR 257.103) or an initial application for an Alternate Liner Demonstration is prepared per 40 CFR § 257.71(d) and submitted by November 30, 2020. The April 11, 2021 deadline to cease receipt of waste and initiate closure will be tolled upon submission of a complete application and until such time that EPA makes a final decision on the application or subsequent demonstration. The initial application for an Alternate Liner Demonstration per § 257.71(d)(1)(i) must include the location of the facility and identify the specific CCR surface impoundment(s) for which the demonstration will be made. The application must also include all the following information:

- **§ 257.71(d)(1)(i)(A)** – A certification signed by the owner or operator that the CCR Unit is in full compliance with this subpart except for § 257.71(a)(1);
- **§ 257.71(d)(1)(i)(B)** – Documentation supporting the certification required under § 257.71(d)(1)(i)(A) which includes the following:
 1. Documentation that the groundwater monitoring network meets the requirements of § 257.91. This must include documentation that the existing network of groundwater monitoring wells is sufficient to ensure detection of any groundwater contamination resulting from the impoundment, based on direction of flow, well location, screening depth and other relevant factors;
 2. Documentation that the CCR surface impoundment remains in detection monitoring pursuant to § 257.94 as a precondition for submitting an application. This includes documentation that the groundwater monitoring program meets the requirements of § 257.93 and § 257.94;
 3. Documentation that the unit meets all the location restrictions under § 257.60 through 257.64;
 4. Documentation of the most recent structural stability assessment required by § 257.73(d); and
 5. Documentation of the most recent safety factor assessment required by § 257.73(e).
- **§ 257.71(d)(1)(i)(C)** – Documentation of the design specifications for any engineered liner components, as well as all data and analyses the owner or operator of the CCR surface impoundment relied on when determining the materials are suitable for use and that the construction of the liner is of good quality and in-line with proven and accepted engineering practices;
- **§ 257.71(d)(1)(i)(D)** – Facilities with CCR surface impoundments located on properties adjacent to a water body must demonstrate that there is no reasonable probability that a complete and direct transport pathway (i.e., not mediated by groundwater) can exist between the impoundment and any nearby water body; and

- **§ 257.71(d)(1)(i)(E)** – Upon submission of the application, and any supplemental materials submitted in support of the application to the Administrator or the Participating State Director, the owner or operator must place the complete application in the facility's operating record as required by § 257.105(f)(14).

The documentation that must be provided to the EPA per § 257.71(d)(1)(i) to demonstrate that the above criteria has been met for an initial Alternate Liner Demonstration is provided within this report.

Site Background - The BRPP is located in Section 13, Township 4 North, Range 16 East at 4505 King Road, China Township in St. Clair County, Michigan (**Figure 1**). The BRPP, including the DB, was constructed in the early 1980s.

The property has been used continuously as a coal fired power plant since the Detroit Edison Company (now DTE Electric) began power plant operations at BRPP in 1984. The DB is designed to manage sluiced bottom ash and has been in operation since the BRPP began operation. The DB is routinely cleaned out and CCR is either beneficially reused or disposed at the Range Road Landfill (RRLF).

The BRPP DB is an incised CCR surface impoundment located west of the BRPP near the Webster Drain. Water flows into the DB from the North and South bottom ash basins (BABs) through a network of pipes and ditches (**Figure 2**). The DB discharges to the St. Clair River with other site wastewater in accordance with a National Pollution Discharge Elimination System (NPDES) permit. The DB has an approximately 300-foot-long entrance channel that connects to the main portion of the basin that runs approximately north-south. The main portion of the DB is approximately 400 feet long by approximately 120 feet wide with a bottom elevation of approximately 576 feet with the water level being maintained at approximately 580 feet relative to the NAVD 1988. The capacity of the DB is approximately 5.2 million gallons. The DB is approximately 1.55 acres.

2.0 Natural Clay Liner

Pursuant to Part B, in order to meet the requirements of 40 CFR § 257.71(d)(1), the owner or operator must demonstrate that, without a composite liner, the continued operation of the unit would pose no reasonable probability of adverse effects to human health or the environment. This is demonstrated when the surface impoundment has not and will not result in groundwater concentrations above the relevant GWPS at the unit boundary (health based or background, whichever is higher).

The risks posed by the continued operation of the DB CCR Unit are mitigated by the geologic and hydrogeologic conditions at the site, and through DTE Electric's demonstrated compliance with the CCR rules. The following paragraphs document the existing site conditions, identification of potential receptors, and how potential risks have been mitigated.

Site Geology - The geology of St. Clair County consists of approximately 101 to 400 feet of glacial deposits, primarily lacustrine deposits, till, and, to a lesser extent, sand and gravel outwash, overlying a variety of bedrock surfaces¹. The thicker glacial deposits, predominantly low permeability clay-rich deposits, are present toward the central portion of the county, including in the area of the BRPP DB CCR Unit. These thick low permeability subsurface conditions are present on a regional basis due to continental glaciation. The *Natural Clay Liner Equivalency Evaluation Report, DTE Electric and Consumers Energy Company Six Southeast Michigan Coal Combustion Residual Units*, previously submitted to the EPA in December of 2018, also contains additional information on the natural clay liner evaluation. This report can be found here: [Clay Liner Equivalency Report](#). Bedrock in the county includes the Michigan Formation, Marshall Sandstone, Coldwater Shale, Sunbury Shale, Berea Sandstone, Bedford Shale, and Antrim Shale.

In the vicinity of the site, the Devonian Bedford and/or Antrim Shale bedrock dips to the northwest and is generally covered by more than 100 feet of unconsolidated clay, silt, sand, and gravel. In this area, generally on the eastern side of the county, the glacial deposits are predominantly silty-clay till and lacustrine deposits with lenses of sand and gravel. Where present, unconsolidated sand and gravel deposits within the till and lacustrine deposits are generally used for water supply throughout the county. Approximately 85 percent of the water supply wells in St. Clair County are completed in the glacial deposits compared to approximately 13 percent installed in bedrock¹.

The current topography of the St. Clair area gently undulates consisting of floodplain, stream terrace, and lakeshore deposits. The St. Clair River is the major surface water body in the county and runs along the eastern boundary of the county. Regional groundwater and surface water flow would be expected to be to the east towards the St. Clair River.

The site subsurface geology is based on information from historical borings advanced during initial design of the BRPP, in addition to the soil boring data collected from around the DB during

¹ Beth A. Apple and Howard W. Reeves, 2007, Summary of Hydrogeologic Conditions by County for the State of Michigan. U.S. Geological Survey Open-File Report 2007-1236, 78 p.

the groundwater monitoring system installation. This information documents that the BRPP DB CCR Unit is underlain by more than 130 feet of vertically thick and laterally continuous silty-clay rich deposits, with the lower confining Bedford Shale generally encountered from 135 to 145 feet-below ground surface (feet-bgs). Although the encountered zone of saturation along the bedrock interface did not yield significant groundwater, it was conservatively interpreted as the first underlying saturated zone that would presumably become affected with CCR constituents. The zone of saturation also exhibited a much higher conductivity than the clay-rich soils between the bottom of the basin and the monitored zone. In addition, the underlying shale does not yield groundwater, rather it is an aquiclude that prevents groundwater flow (i.e., is not an aquifer). Refer to the Groundwater Monitoring Systems Summary Report (GWMS, October 2017) located on the DTE Compliance Data and Information website ([BRPP GWMS](#)) and **Figures 3 through 5** for further details on the site geology.

Site Hydrogeology – Based on data collected by TRC from monitoring wells near the DB CCR unit, there is an overall flow potential to the north-northwest with a mean gradient of 0.003 foot/foot from the CCR monitoring wells MW-16-06 through MW-16-08 (up gradient) on the east side of the DB CCR unit towards monitoring wells MW-16-05, MW-16-10 and MW-16-11/11A (down gradient). The GWMS report ([BRPP GWMS](#)) contains additional details related to the site hydrogeology.

For the DB CCR unit, assuming an average porosity of 0.4 for the silt in the uppermost aquifer in this area, the mean hydraulic conductivity of 0.2 feet/day and a hydraulic gradient of 0.003 foot/foot for the upper aquifer, the potential horizontal groundwater flow rate to approximately the north-northwest is approximately 0.0015 feet/day or 0.55 feet/year. Given low flow velocity of this zone, inter-well (upgradient to downgradient) statistical tests are inappropriate for detection monitoring of this basin.

In addition, the elevation of CCR-affected water maintained within the BRPP DB is approximately 5 to 15 feet above the potentiometric surface elevations in the uppermost aquifer at the DB CCR unit area. This suggests that if the CCR affected surface water in the DB were able to penetrate the silty clay-rich underlying confining unit head on, that release likely would travel radially away from the DB within the uppermost aquifer. However, with the very thick continuous silty clay-rich confining unit beneath the BRPP it is not possible for the uppermost aquifer to have been affected by CCR from BRPP operations that began in the 1980s (see vertical travel time of travel discussion below).

For further discussion on the site groundwater flow see **Appendix A** for the 2019 Annual Groundwater Monitoring Report (GWMR). The 2018 and 2017 GWMR reports can be located on DTE CCR Compliance Data and Information website ([BRPP 2018 GWMR](#) and [BRPP 2017 GWMR](#)). Refer to **Figures 6 and 7** for the most recent potentiometric surface maps.

Vertical Flow Potential to Uppermost Aquifer – As stated previously, the BRPP is a natural silty-clay site, and the presence of the natural clay liner has been verified by numerous historical soil borings and confirmed by the twelve soil borings installed as part of the CCR monitoring well installation program at the BABs and DB CCR Units. Therefore, the geology and

hydrogeology of the site provides a very high level of environmental protection of the uppermost aquifer. Based on the site geology and hydrogeology, there is no reasonable probability for the impoundment to have adverse effects to the off-site uppermost aquifer groundwater, human health or the environment given the relatively short duration of continued operation.

Groundwater occurring in the deep confined uppermost aquifer is protected from CCR constituents in the DB by a clay-rich aquitard with low hydraulic conductivity that is more than 82 feet thick from the bottom of the DB. Using the hydrogeologic information for the site, the time of travel for water from the base-grade elevation of the DB down to the uppermost aquifer can be calculated using the following formula:

$$V = Ki/Ne$$

Where:

V = Velocity (feet/day)

K = Hydraulic Conductivity (3×10^{-8} cm/s based on high end silty clay-rich data)

i = Downward Vertical Gradient (conservatively assumed to be one foot/foot)

Ne = Effective Porosity (0.5 for clay-rich soil)

From the above formula, the maximum downward flow velocity through the silty-clay confining unit to the uppermost aquifer is 6×10^{-8} cm/sec, or 0.063 feet/year. Therefore, the time of travel for liquid from the base of the DB through 82 feet of silty-clay (thinnest potential section of silty-clay confining unit above the uppermost aquifer at the base of the DB CCR Unit) to the uppermost aquifer is approximately 1,300 years. Therefore, given that BRPP operations began in 1984, and the fact that DTE Electric has publicly announced that it plans to cease operations at the BRPP by 2030 (refer to the 2019 Integrated Resource Plan (IRP) presented to and approved by the Michigan Public Service Commission ([IRP](#))), there is no potential for the uppermost aquifer CCR groundwater monitoring system wells to be affected by the BRPP CCR DB Unit. Therefore, the natural clay-rich soil liner underlying the DB CCR Unit consists of thick, low hydraulic conductivity clay, that provides the same, or better level of protection from potential migration of contaminants than the composite liner defined in 40 CFR § 257.70(b).

Groundwater Use - Water supply wells are present within the sand and/or gravel rich aquifer units within the lacustrine unconsolidated sediments at depths of around 100 feet-bgs within between one-half and one mile to the west and southwest of the BRPP. There is no on-site use of groundwater at the BRPP. Surface water bodies present in the area of the BRPP include the Belle River (as close as 2,000 feet southwest and south of BRPP) and the St. Clair River (as close as one mile to the east of BRPP).

Detection Monitoring - A groundwater monitoring system has been established for the BRPP DB CCR Unit ([BRPP GWMS](#)). The detection monitoring well network for the DB CCR Unit currently consists of six monitoring wells that are screened in the uppermost aquifer. The monitoring well locations are shown on **Figure 2**. Detection monitoring at the monitoring well system has been completed since 2017 in accordance with § 257.93 and § 257.94 with

compliance as required in § 257.71(d)(1)(i)(B)(2) being documented in the 2017, 2018 and 2019 Annual Reports prepared in accordance with § 257.90. See **Appendix A** for the 2019 GWMR, and the DTE website for the 2018 and 2017 GWMRs ([BRPP 2018 GWMR](#) and [BRPP 2017 GWMR](#)).

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3.0 Facility Compliance

DTE Electric has a public repository of documents in accordance with 40 CFR § 257.107 which can be found here: [DTE CCR Compliance Data and Information](#). This repository demonstrates that the BRPP DB facility is in compliance with all record keeping, notification and internet posting requirements as required by 40 CFR 257 Subpart D. DTE Electric audited their records to identify any gaps in compliance and none were noted. As required by § 257.71(d)(1)(i)(A), a certification signed by the owner or operator that the BRPP DB CCR Unit is in full compliance with this subpart, except for § 257.71(a)(1), has been included as **Appendix B**. A summary of the key compliance metrics for the BRPP DB CCR Unit is discussed below.

Groundwater Monitoring System § 257.71(d)(1)(i)(B)(1) – In accordance with 40 CFR § 257.91, a P.E. certified groundwater monitoring system is established for the BRPP DB CCR Unit ([BRPP GWMS](#)). The monitoring well network for the DB CCR Unit currently consists of six monitoring wells that are screened in the uppermost aquifer and are sufficient to ensure detection of groundwater contamination resulting from the DB CCR Unit. Given the presence of the thick natural clay-rich liner hydraulic barrier as discussed in Section 2 and the relatively small foot print of the DB, the perimeter groundwater monitoring well network is appropriate to monitor the BRPP DB CCR Unit. The monitoring well locations are shown on **Figure 2**. Well Construction and Soil Boring Logs for the monitoring network are attached as **Appendix C**.

Groundwater elevation data collected during the 2019 sampling events show that groundwater flow conditions within the uppermost aquifer are consistent with previous monitoring events. Groundwater potentiometric elevation summary maps are shown on **Figure 6 and Figure 7**, respectively. Additional figures for 2017 and 2018 can be found in the 2017 and 2018 GWMRs located on the DTE website ([BRPP 2018 GWMR](#) and [BRPP 2017 GWMR](#)). There is a horizontally extensive clay with substantial vertical thickness of greater than 80 feet that isolates the uppermost aquifer from the BRPP DB CCR Unit (refer to **Figures 3, 4 and 5** for geologic cross sections).

Detection Monitoring and Groundwater Statistical Analysis § 257.71(d)(1)(i)(B)(2) – The groundwater conditions have been consistent through all monitoring events completed since 2017. This continues to demonstrate that the downgradient wells are appropriately positioned to detect the presence of Appendix III parameters that could potentially migrate from the BRPP DB CCR Unit. This additionally demonstrates the unit has been in compliance with detection monitoring performed in accordance with § 257.94 as required in § 257.71(d)(1)(i)(B)(2). This is documented in the 2017 through 2019 Annual Reports prepared as required by 40 CFR § 257.90. The 2019 GWMR is attached as **Appendix A**, 2018 and 2017 GWMRs can be found on the DTE website located here: ([BRPP 2018 GWMR](#) and [BRPP 2017 GWMR](#)).

Since establishment of the groundwater monitoring system, DTE Electric performs groundwater sampling semi-annually in accordance with the Groundwater Statistical Evaluation Plan (SEP, October 2017) located on the DTE website here: [BRPP SEP](#).

Statistical evaluation of groundwater data is completed each time samples are collected in accordance with 40 CFR § 257.93. Statistical methods for the DB CCR Unit were selected

based on the geology and hydrogeology at the Site (primarily the presence of clay/hydraulic barrier, the relatively small footprint of the DB, and the low vertical and horizontal groundwater flow velocity), in addition to other supporting lines of evidence that the aquifer is unaffected by the CCR Unit (such as the consistency in concentrations of water quality data). Refer to the SEP (October 2017) located on the DTE website here [BRPP SEP](#), for further details on the statistical analysis and the 2019 GWMR attached as **Appendix A** for a summary of groundwater monitoring data and statistical analysis completed at each monitoring location. The 2018 and 2017 GWMRs are located on the DTE website here: ([BRPP 2018 GWMR](#) and [BRPP 2017 GWMR](#)).

Location Standards § 257.71(d)(1)(i)(B)(3) – The BRPP DB CCR Unit is compliant with the location restrictions of 40 CFR § 257.60-64. The location restriction certification report (LR, October 2018) is available on the DTE website here: [BRPP LR](#).

Structural Stability and Safety Factor Assessments § 257.71(d)(1)(i)(B)(4 and 5) - Structural stability assessment and safety factor assessments, as required per 40 CFR §257.103 (f)(2)(v)(C)(7) and (8), are not required for the BRPP DB incised surface impoundment and have therefore not been included with this submittal.

Documentation of Design Specifications § 257.71(d)(1)(i)(C) – As the BRPP DB relies on the natural clay liner, a design for the liner was not performed. However, prior to the construction of BRPP, a significant geotechnical investigation demonstrated extensive clay deposits across the entire BRPP site as documented in a 1976 *Subsurface Investigation and Foundation Report* by Bechtel. The Bechtel report included an evaluation of the native natural clay soils that were used in construction of the BRPP DB CCR Unit surface impoundment that is incised into the natural clay liner. The evaluation included soil hydraulic conductivity testing showing the native clay soil has a hydraulic conductivity around 2×10^{-8} cm/s. The 1976 Bechtel report is provided in **Appendix D**.

report by Bechtel. Documentation of the BRPP DB natural clay liner assessment, design and as built drawings indicating the DB surface impoundments are incised into the natural clay liner are provided in **Appendix D**.

Facilities with CCR surface impoundments located on properties adjacent to a water body § 257.71(d)(1)(i)(D) – The BRPP DB CCR Unit is not located adjacent to a surface water body.

Alternate Liner Application Placed in the Operating Record - § 257.71(d)(1)(i)(E) - This alternate liner demonstration application and supplemental materials submitted in this application have been placed in the facility's operating record as required by § 257.105(f)(14).

4.0 Conclusions

This document demonstrates how the BRPP DB CCR Unit meets the provisions of the initial application for an alternate liner demonstration by:

- Demonstrating continued compliance with the CCR Rule for all record keeping, notification and internet posting requirements. In addition, detection monitoring is completed at the established groundwater monitoring network as required by 40 CFR § 257.93 and § 257.94 and annual reporting as required by 40 CFR § 257.90 documents compliance with the detection monitoring program;
- Demonstrating the presence of a natural geologic barrier underlying the BRPP DB CCR Unit, that consists of a thick (> 80 feet), low hydraulic conductivity clay, that provides the same, or better level of protection from potential migration of contaminants than the composite liner defined in 40 CFR § 257.70(b);
- Demonstrating that the BRPP DB CCR Unit is compliant with the location restrictions of 40 CFR § 257.60-64 and that the structural stability and safety factor assessments per 40 CFR § 257.103 (f)(2)(v)(C)(7) and (8) are not required;
- Including the BRPP DB impoundment natural clay liner soil assessment performed prior to construction of the DB surface impoundment;
- Documenting the BRPP DB is not located adjacent to a surface water body; and
- Placing this alternate liner demonstration application and supplemental materials submitted in this application in the facility's operating record as required by § 257.105(f)(14).

Therefore, it is requested that the EPA approve DTE Electric's initial application to complete an alternate liner demonstration prepared per 40 CFR § 257.71(d)(i) for the BRPP DB CCR Unit.

5.0 References

DTE Electric Company website: [DTE CCR Compliance Data and Information](#)

TRC Environmental Corporation. January 2020. 2019 Annual Groundwater Monitoring Report - DTE Electric Company Belle River Power Plant Diversion Basin, 4505 King Road, China Township, Michigan 48054 ([BRPP 2019 GWMR](#)).

TRC Environmental Corporation. January 2019. 2018 Annual Groundwater Monitoring Report - DTE Electric Company Belle River Power Plant Diversion Basin, 4505 King Road, China Township, Michigan 48054 ([BRPP 2018 GWMR](#)).

TRC Environmental Corporation. January 2018. 2017 Annual Groundwater Monitoring Report - DTE Electric Company Belle River Power Plant Diversion Basin, 4505 King Road, China Township, Michigan 48054 ([BRPP 2017 GWMR](#)).

TRC Environmental Corporation. October 2017. Groundwater Monitoring Systems Summary Report - DTE Electric Company Belle River Power Plant Diversion Basin, 4505 King Road, China Township, Michigan 48054 ([BRPP GWMS](#)).

TRC Environmental Corporation. October 2017. Groundwater Statistical Evaluation Plan - DTE Electric Company Belle River Power Plant Diversion Basin, 4505 King Road, China Township, Michigan 48054 ([BRPP SEP](#)).

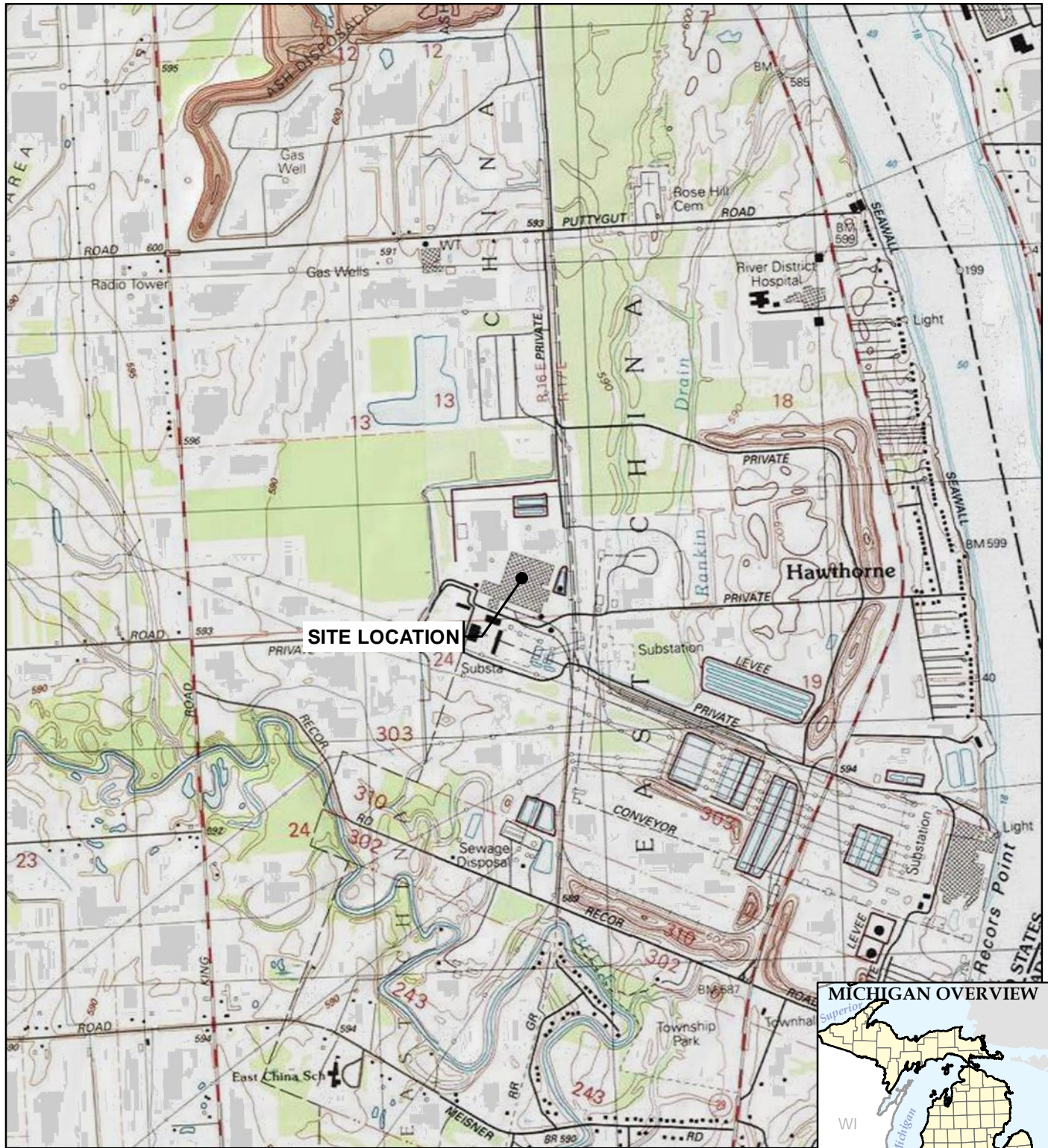
TRC Environmental Corporation. October 2018. Location Restrictions Demonstrations - DTE Electric Company Belle River Power Plant Diversion Basin, 4505 King Road, China Township, Michigan 48054 ([BRPP LR](#)).

TRC Environmental Corporation. December 2018. Natural Clay Liner Equivalency Evaluation Report, DTE Electric and Consumers Energy Company Six Southeast Michigan Coal Combustion Residual Units ([Clay Liner Equivalency Report](#))

Bechtel. August 1976. Subsurface Investigation and Foundation Report – The Detroit Edison Company, Belle River Units 1 & 2.

Figures

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BASE MAP FROM USGS 7.5 MINUTE TOPOGRAPHIC QUADRANGLE SERIES.



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TRC - GIS

PROJECT:

**DTE ELECTRIC COMPANY
BELLE RIVER POWER PLANT
4505 KING ROAD
CHINA TOWNSHIP, MICHIGAN**

TITLE:

SITE LOCATION MAP

DRAWN BY:

S. MAJOR

CHECKED BY:

J. KRENZ

APPROVED BY:

V. BUENING

DATE:

JANUARY 2020

PROJ. NO.:

320511.0003




FILE:

320511-0003-003slmMB.mxd

FIGURE 1

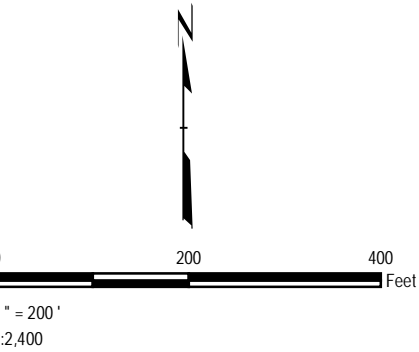



LEGEND

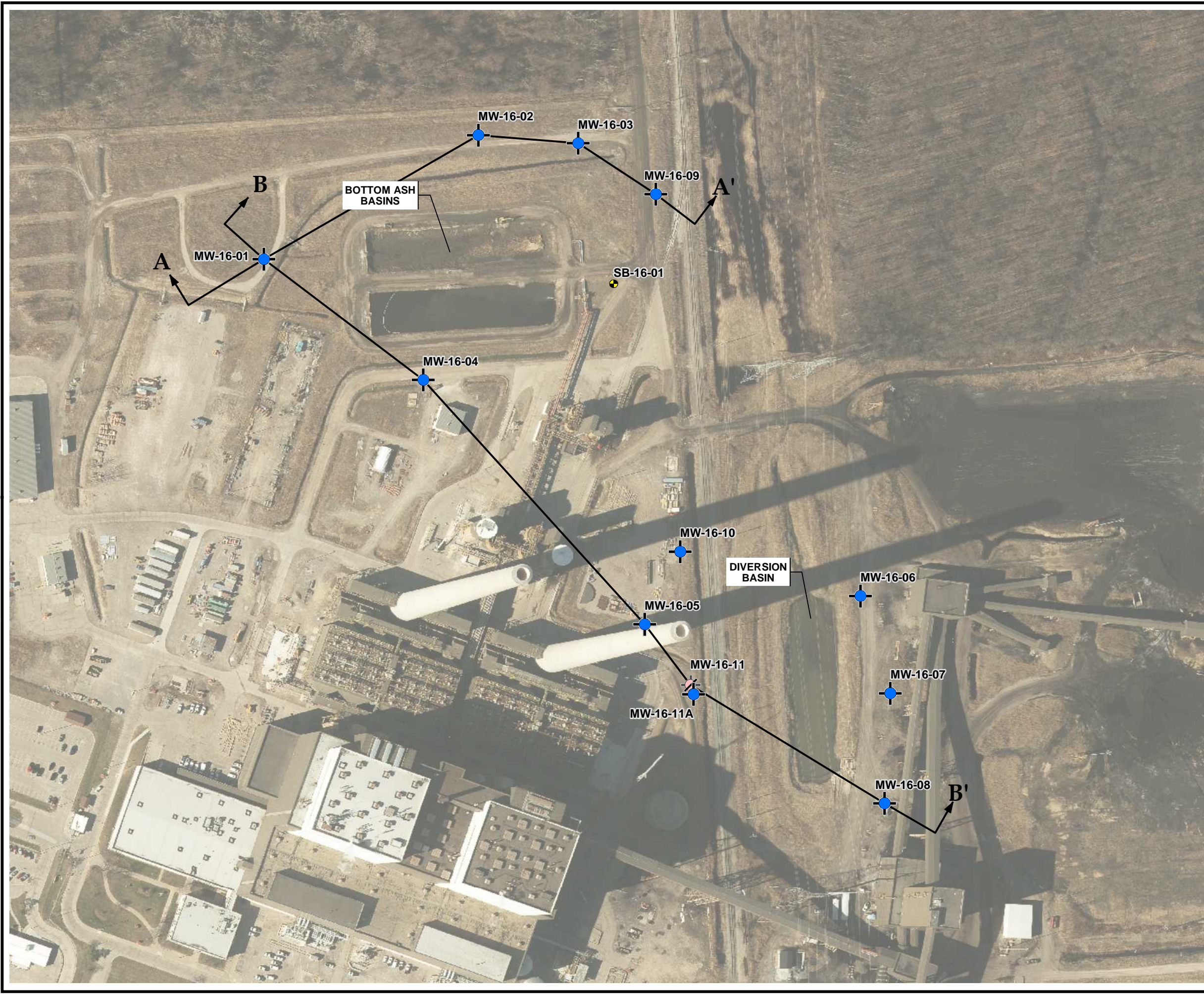
-  SOIL BORING
-  MONITORING WELL
-  DECOMMISSIONED MONITORING WELL

NOTES

- BASE MAP IMAGERY FROM GOOGLE EARTH PRO. & PARTNERS, (3/24/2019).
- WELL LOCATIONS SURVEYED IN MARCH, APRIL, JUNE 2016, AND JUNE 2017 BY BMJ ENGINEERS & SURVEYORS, INC.



PROJECT:		DTE ELECTRIC COMPANY BELLE RIVER POWER PLANT DIVERSION BASIN 4505 KING ROAD CHINA TOWNSHIP, MICHIGAN	
TITLE:		SITE PLAN	
DRAWN BY:	M. VAPHIADIS	PROJ NO.:	320511.0003.0000 P1 T1
CHECKED BY:	J. KRENZ	FIGURE 2	
APPROVED BY:	V. BUENING		
DATE:	JANUARY 2020		
		1540 Eisenhower Place Ann Arbor, MI 48108-3284 Phone: 734.971.7080 www.trccompanies.com	
FILE NO.:		320511-0003-025.mxd	



LEGEND

- SOIL BORING
- MONITORING WELL
- DECOMMISSIONED MONITORING WELL
- CROSS SECTIONS

NOTES

- BASE MAP IMAGERY FROM ST. CLAIR COUNTY INFORMATION TECHNOLOGY DEPARTMENT WEBMAP, 2015.
- WELL LOCATIONS SURVEYED IN MARCH, APRIL, JUNE 2016, AND JUNE 2017.

PROJECT:		DTE ELECTRIC COMPANY BELLE RIVER POWER PLANT 4505 KING ROAD CHINA TOWNSHIP, MICHIGAN	
TITLE: CROSS SECTION LOCATOR MAP			
DRAWN BY: J. PAPEZ		PROJ NO.: 265996.0003	
CHECKED BY: S. HOLMSTROM		FIGURE 3	
APPROVED BY: V. BUENING			
DATE: OCTOBER 2017			

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Phone: 734.971.7080
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FILE NO.: 265996-0003-011.mxd

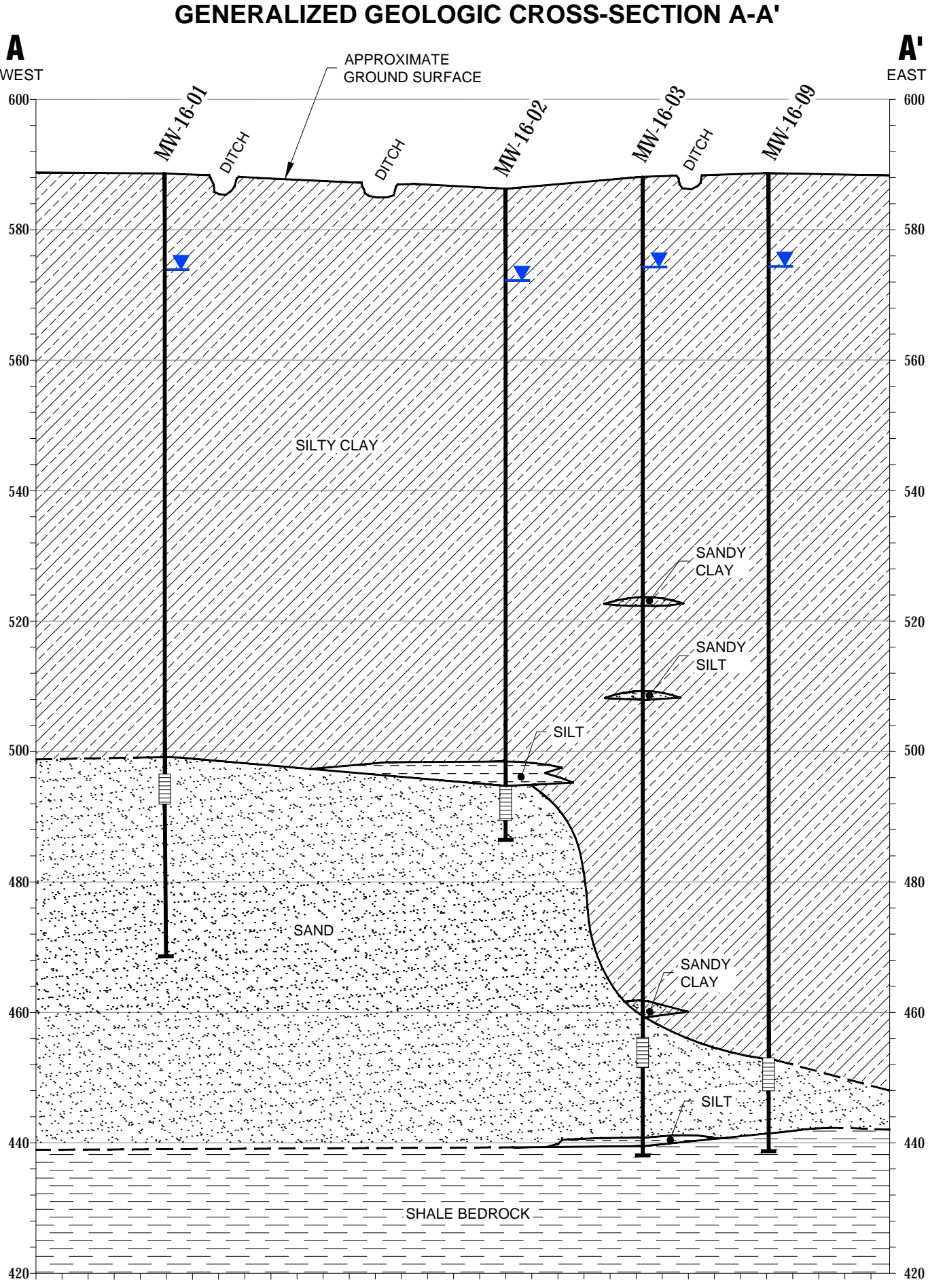






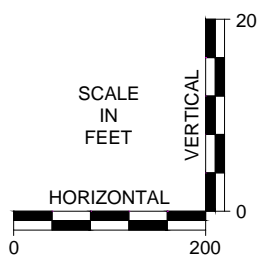



Diagram illustrating the components of a soil boring log:

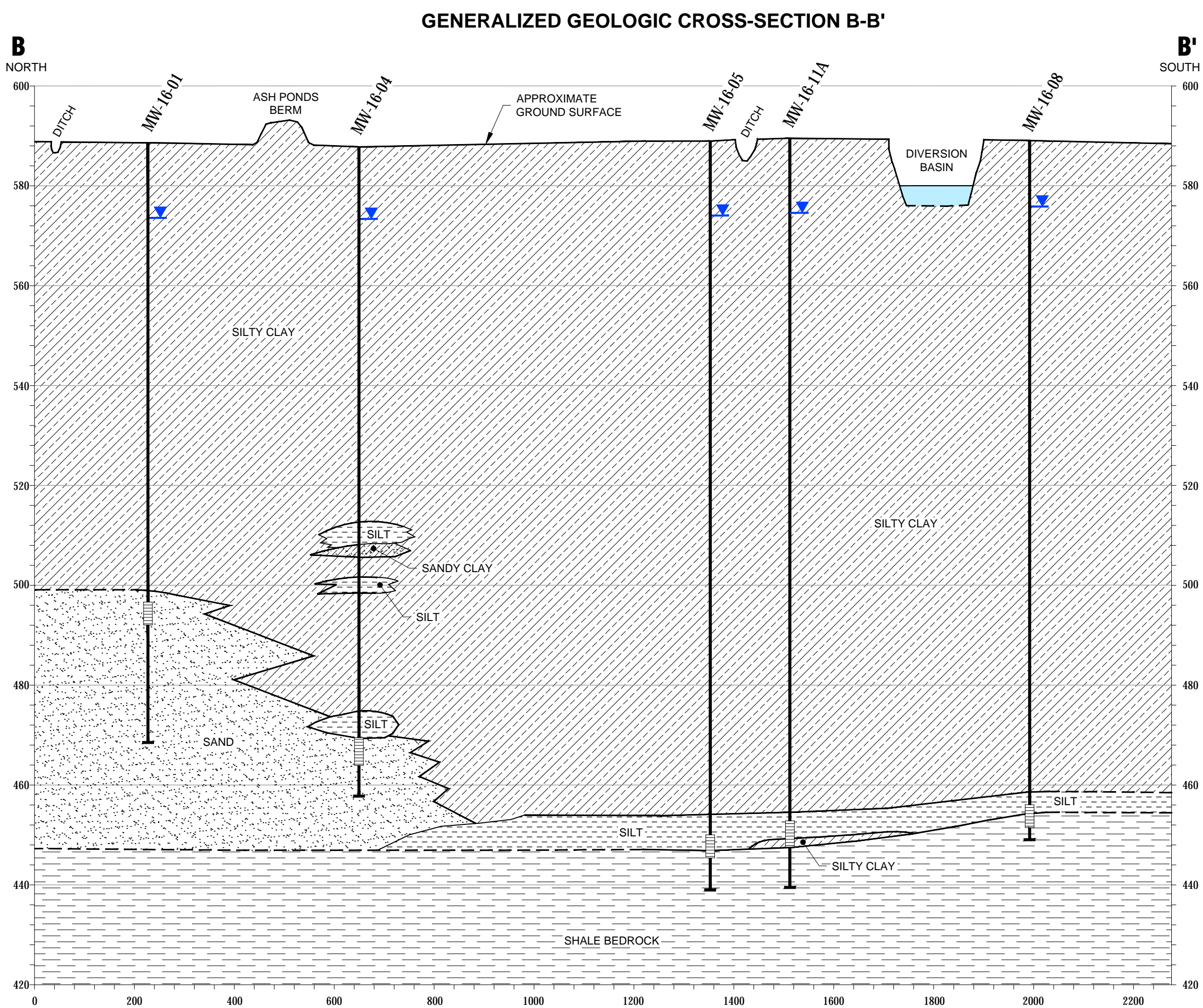
- STRATIGRAPHIC BOUNDARY (DASHED WHERE INFERRED)
- GROUNDWATER ELEVATION (COLLECTED 02/27/2017)
- SOIL BORING
- WELL SCREEN INTERVAL
- END OF BORING

	SILTY CLAY
	SAND
	SILT
	SANDY CLAY
	SANDY SILT
	SHALE BEDROCK



PROJECT:		DTE ELECTRIC COMPANY BELLE RIVER POWER PLANT CHINA TOWNSHIP, MICHIGAN	
TITLE:			
GENERALIZED GEOLOGIC CROSS-SECTION A-A'			
DRAWN BY:	D.STEHELE	PROJ NO.:	265996.0003.01
CHECKED BY:	S.HOLMSTROM	FIGURE 4	
APPROVED BY:	V.BUENING		
DATE:	SEPTEMBER 2017		
		1540 Eisenhower Place Ann Arbor, MI 48108 Phone: 734.971.7080 www.trcsolutions.com	
FILE NO.:	265996.0003.01.04-05.dwg		






11x17 --- ATTACHED XREFS: --- ATTACHED IMAGES: DTE BRPP XS XXXXXXXXXXXX-02172017092213_Page_1; DTE BRPP XS XXXXXXXXXXXX-02172017092213_Page_2; XS aa wells; XS cc wells; XS DD wells; DRAWING NAME: F:\TRC\DEBelle River\PP265996\0003\265996.0003.01.04.05.dwg --- PLOT DATE: October 10, 2017 - 6:47AM --- LAYOUT: FIG05 XS BB

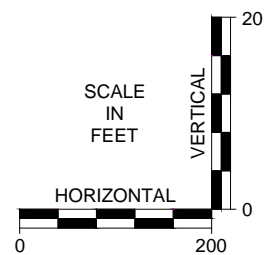



LEGEND

- STRATIGRAPHIC BOUNDARY (DASHED WHERE INFERRED)
- GROUNDWATER ELEVATION (COLLECTED 02/27/2017)
- SOIL BORING
- WELL SCREEN INTERVAL
- END OF BORING

Lithology Key

	SILTY CLAY
	SAND
	SILT
	SANDY CLAY
	SHALE BEDROCK



PROJECT:		DTE ELECTRIC COMPANY BELLE RIVER POWER PLANT CHINA TOWNSHIP, MICHIGAN	
TITLE:		GENERALIZED GEOLOGIC CROSS-SECTION B-B'	
DRAWN BY:	D.STEHLE	PROJ NO.:	265996.0003
CHECKED BY:	S.HOLMSTROM	FIGURE 5	
APPROVED BY:	V.BUENING		
DATE:	SEPTEMBER 2017		
		1540 Eisenhower Place Ann Arbor, MI 48108 Phone: 734.971.7080 www.trcsolutions.com	
FILE NO.:		265996.0003.01.04-05.dwg	



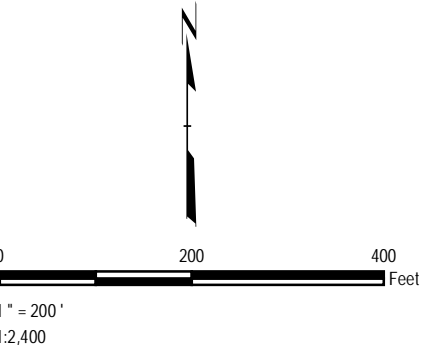
Monitoring Well Screen Information			
Monitoring Well ID	Screen Interval Lithology	Screen Interval Depth (ft BGS)	Screen Interval Elevation (ft NAVD 88)
MW-16-05	Clayey Silt to Shale bedrock	139.0 - 144.0	449.3 - 444.3
MW-16-06	Silt to Shale bedrock	135.0 - 140.0	455.0 - 450.0
MW-16-07	Silt to Shale bedrock	133.0 - 138.0	456.9 - 451.9
MW-16-08	Silt to Shale bedrock	133.0 - 138.0	456.3 - 451.3
MW-16-10	Gravelly Silt to Silty Clay	145.0 - 150.0	444.3 - 439.3
MW-16-11	Clay and Sandy Clay	137.0 - 142.0	452.0 - 447.0
MW-16-11A	Silt to Shale bedrock	137.0 - 142.0	452.5 - 447.5

LEGEND

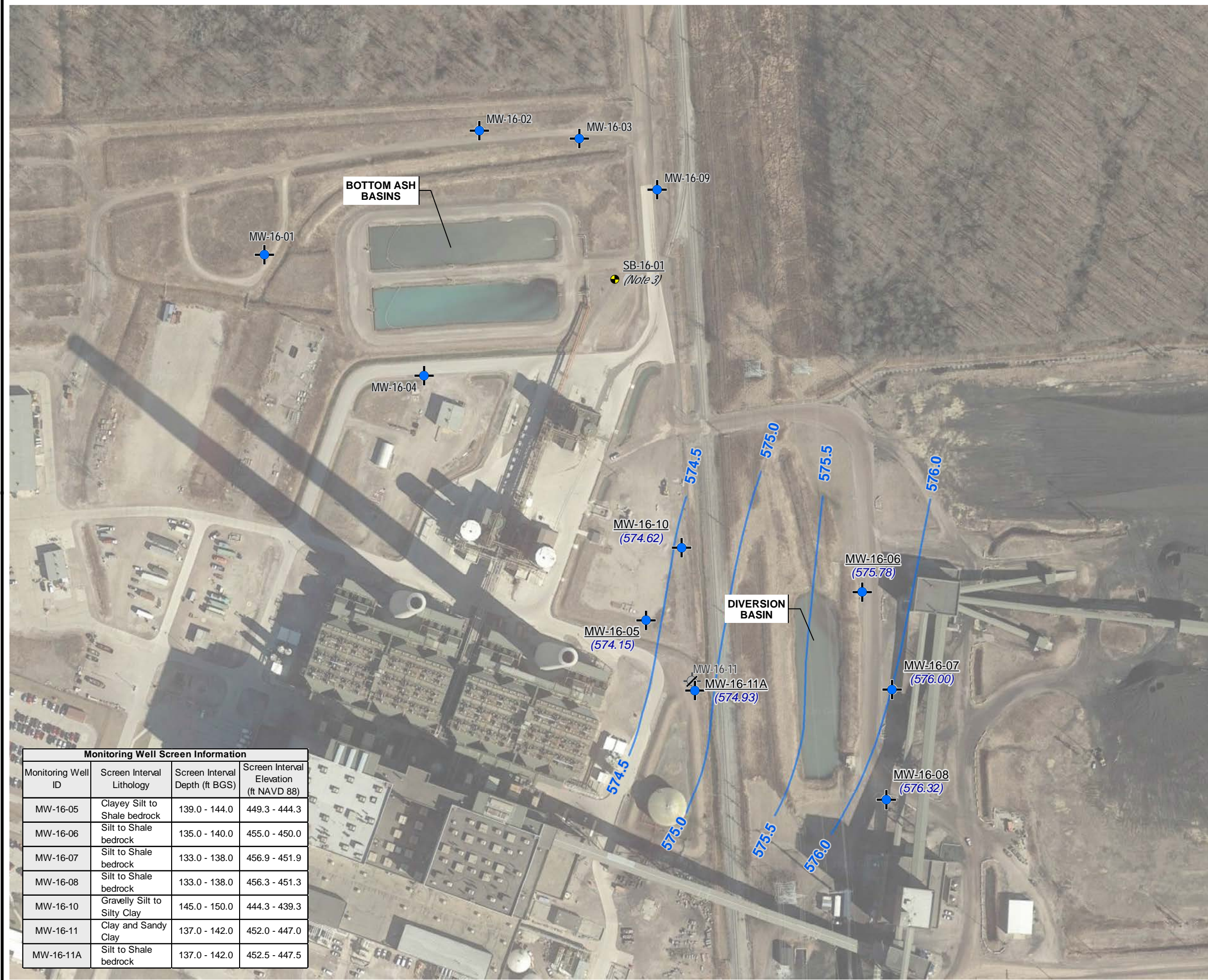
- SOIL BORING
- MONITORING WELL
- DECOMMISSIONED MONITORING WELL
- (575.47) GROUNDWATER ELEVATION (FT NAVD 88)
- GROUNDWATER ELEVATION CONTOUR (0.5-FT INTERVAL, DASHED WHERE INFERRED)

NOTES

- BASE MAP IMAGERY FROM GOOGLE EARTH PRO, (3/24/2019).
- WELL LOCATIONS SURVEYED IN MARCH, APRIL, AND JUNE 2016 BY BMJ ENGINEERS AND SURVEYORS. INC.
- NO SAND OR GRAVEL UNIT PRESENT ABOVE BEDROCK IN THIS LOCATION.
- GROUNDWATER ELEVATIONS DISPLAYED IN FEET RELATIVE TO NORTH AMERICAN VERTICAL DATUM OF 1988.



PROJECT:		DTE ELECTRIC COMPANY BELLE RIVER POWER PLANT DIVERSION BASIN 4505 KING ROAD CHINA TOWNSHIP, MICHIGAN	
TITLE:		DIVERSION BASIN GROUNDWATER POTENTIOMETRIC SURFACE MAP MARCH 2019	
DRAWN BY:	M. VAPHIADIS	PROJ NO.:	386089.0001
CHECKED BY:	J. KRENZ	FIGURE 6	
APPROVED BY:	V. BUENING		
DATE:	OCTOBER 2020		
		1540 Eisenhower Place Ann Arbor, MI 48108-3284 Phone: 734.971.7080 www.trccompanies.com	
FILE NO.:		386089-0001-006.mxd	



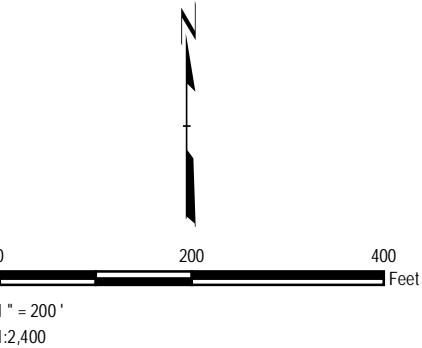
Monitoring Well Screen Information			
Monitoring Well ID	Screen Interval Lithology	Screen Interval Depth (ft BGS)	Screen Interval Elevation (ft NAVD 88)
MW-16-05	Clayey Silt to Shale bedrock	139.0 - 144.0	449.3 - 444.3
MW-16-06	Silt to Shale bedrock	135.0 - 140.0	455.0 - 450.0
MW-16-07	Silt to Shale bedrock	133.0 - 138.0	456.9 - 451.9
MW-16-08	Silt to Shale bedrock	133.0 - 138.0	456.3 - 451.3
MW-16-10	Gravelly Silt to Silty Clay	145.0 - 150.0	444.3 - 439.3
MW-16-11	Clay and Sandy Clay	137.0 - 142.0	452.0 - 447.0
MW-16-11A	Silt to Shale bedrock	137.0 - 142.0	452.5 - 447.5

LEGEND

- SOIL BORING
- MONITORING WELL
- DECOMMISSIONED MONITORING WELL
- (575.47) GROUNDWATER ELEVATION (FT NAVD 88)
- GROUNDWATER ELEVATION CONTOUR (0.5-FT INTERVAL, DASHED WHERE INFERRED)

NOTES

- BASE MAP IMAGERY FROM GOOGLE EARTH PRO, (3/24/2019).
- WELL LOCATIONS SURVEYED IN MARCH, APRIL, AND JUNE 2016 BY BMJ ENGINEERS AND SURVEYORS. INC.
- NO SAND OR GRAVEL UNIT PRESENT ABOVE BEDROCK IN THIS LOCATION.
- GROUNDWATER ELEVATIONS DISPLAYED IN FEET RELATIVE TO NORTH AMERICAN VERTICAL DATUM OF 1988.



PROJECT:

DTE ELECTRIC COMPANY
BELLE RIVER POWER PLANT DIVERSION BASIN
4505 KING ROAD
CHINA TOWNSHIP, MICHIGAN

TITLE:

DIVERSION BASIN GROUNDWATER
POTENTIOMETRIC SURFACE MAP
SEPTEMBER 2019

DRAWN BY:

M. VAPHIADIS

PROJ NO.:

386089.0001

CHECKED BY:

J. KRENZ

APPROVED BY:

V. BUENING

DATE:

OCTOBER 2020

FIGURE 7

1540 Eisenhower Place
Ann Arbor, MI 48108-3284
Phone: 734.971.7080
www.trccompanies.com

FILE NO.:

386089-0001-007.mxd

Appendix A

2019 Annual Groundwater Monitoring Report



2019 Annual Groundwater Monitoring Report

**DTE Electric Company
Belle River Power Plant Diversion Basin**

4505 King Road
China Township, Michigan

January 2020




2019 Annual Groundwater Monitoring Report

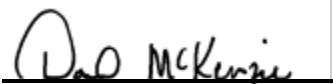
**DTE Electric Company
Belle River Power Plant Diversion Basin**

*4505 King Road
China Township, Michigan*

January 2020

*Prepared For
DTE Electric Company*


Graham Crockford, C.P.G.
Senior Project Geologist


David B. McKenzie, P.E.
Senior Project Engineer

TRC | DTE Electric Company
Final

X:\WPAAM\PJT2\320511\0003\GMR\DB\R320511.3 BRPP DB.DOCX

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Executive Summary

On April 17, 2015, the United States Environmental Protection Agency (USEPA) published the final rule for the regulation and management of Coal Combustion Residuals (CCR) under the Resource Conservation and Recovery Act (RCRA) (the CCR Rule), as amended July 30, 2018. The CCR Rule, which became effective on October 19, 2015 (amendment effective August 29, 2018), applies to the DTE Electric Company (DTE Electric) Belle River Power Plant (BRPP) CCR Diversion Basin (DB) CCR unit. Pursuant to the CCR Rule, no later than January 31, 2018, and annually thereafter, the owner or operator of a CCR unit must prepare an annual groundwater monitoring and corrective action report for the CCR unit documenting the status of groundwater monitoring and corrective action for the preceding year in accordance with §257.90(e). On behalf of DTE Electric, TRC Engineers Michigan, Inc., the engineering entity of TRC Environmental Corporation (TRC), has prepared this Annual Groundwater Monitoring Report for calendar year 2019 activities at the BRPP DB CCR unit.

In the January 31, 2019 *Annual Groundwater Monitoring Report for the Belle River Power Plant Diversion Basin*, covering calendar year 2018 activities potential statistically significant increases (SSIs) over prediction limits were noted for a few Appendix III constituents in one or more downgradient wells during the March and October 2018 monitoring events. However, verification resampling in May and November 2018 did not confirm any of the initial concentrations to be above prediction limits; therefore, the concentrations were not statistically significant, and no SSIs were recorded for either of the 2018 detection monitoring events. As such, DTE Electric continued detection monitoring at the BRPP DB CCR unit pursuant to §257.94 of the CCR Rule.

The semiannual detection monitoring events for 2019 were completed in March and September 2019 and included sampling and analyzing groundwater within the groundwater monitoring system for the indicator parameters listed in Appendix III to the CCR Rule. As part of the statistical evaluation, the data collected during detection monitoring events are evaluated to identify SSIs in detection monitoring parameters to determine if concentrations in detection monitoring well samples exceed background levels. Detection monitoring data that has been collected and evaluated in 2019 are presented in this report.

No SSIs were recorded for the 2019 monitoring period and detection monitoring will be continued at the BRPP DB CCR unit in accordance with §257.94. In addition, with the presence of the vertically and horizontally extensive clay-rich confining till beneath the BRPP DB CCR unit, it is not possible for the uppermost aquifer to have been affected by CCR from operations. Also, due to limitations on CCR Rule implementation timelines, the background data sets are of relatively short duration for capturing the occurrence of natural temporal changes in the aquifer.

Section 1

Introduction

1.1 Program Summary

On April 17, 2015, the United States Environmental Protection Agency (USEPA) published the final rule for the regulation and management of Coal Combustion Residuals (CCR) under the Resource Conservation and Recovery Act (RCRA) (the CCR Rule), as amended July 30, 2018. The CCR Rule, which became effective on October 19, 2015 (amendment effective August 29, 2018), applies to the DTE Electric Company (DTE Electric) Belle River Power Plant (BRPP) Diversion Basin (DB). Pursuant to the CCR Rule, no later than January 31, 2018, and annually thereafter, the owner or operator of a CCR unit must prepare an annual groundwater monitoring and corrective action report for the CCR unit documenting the status of groundwater monitoring and corrective action for the preceding year in accordance with §257.90(e). On behalf of DTE Electric, TRC Engineers Michigan, Inc., the engineering entity of TRC Environmental Corporation (TRC), has prepared this Annual Groundwater Monitoring Report for calendar year 2019 activities at the BRPP DB CCR unit (2019 Annual Report).

In the January 31, 2019 *Annual Groundwater Monitoring Report for the Belle River Power Plant Diversion Basin*, covering calendar year 2018 activities (2018 Annual Report), potential statistically significant increases (SSIs) over prediction limits were noted for a few Appendix III constituents in one or more downgradient wells during the March and October 2018 monitoring events. However, verification resampling in May and November 2018 did not confirm any of the initial concentrations above prediction limits; therefore, the concentrations were not statistically significant, and no SSIs were recorded for either of the 2018 detection monitoring events. As such, DTE Electric continued detection monitoring at the BRPP DB CCR unit in 2019 pursuant to §257.94 of the CCR Rule.

The semiannual detection monitoring events for 2019 were completed in March and September 2019 and included sampling and analyzing groundwater within the groundwater monitoring system for the indicator parameters listed in Appendix III to the CCR Rule. This 2019 Annual Report presents the monitoring results and the statistical evaluation of the detection monitoring parameters (Appendix III to Part 257 of the CCR Rule) for the March and September 2019 semiannual groundwater monitoring events for the BRPP DB CCR unit. Detection monitoring continued to be performed in accordance with the *CCR Groundwater Monitoring and Quality Assurance Project Plan – DTE Electric Company Belle River Power Plant Bottom Ash Basins and Diversion Basin* (QAPP) (TRC, July 2016; revised August 2017) and statistically evaluated per the *Groundwater Statistical Evaluation Plan – Belle River Power Plant Coal Combustion Residual Diversion Basin* (Stats Plan) (TRC, October 2017). As part of the statistical evaluation, the data collected

during detection monitoring events are evaluated to identify SSIs of detection monitoring parameters compared to background levels.

1.2 Site Overview

The BRPP is located in Section 13, Township 4 North, Range 16 East, at 4505 King Road, China Township in St. Clair County, Michigan. The BRPP was constructed in the early 1980s with plant operations beginning in 1984. Prior to Detroit Edison Company's operations commencing in the 1980s, the BRPP property was generally wooded and farmland. The property has been used continuously as a coal fired power plant since Detroit Edison Company (now DTE Electric) began power plant operations at BRPP in 1984 and is generally constructed over a natural clay-rich soil base.

The DB is an incised CCR surface impoundment located east of the BRPP. Water flows into the DB from the North and South bottom ash basins (BABs) through a network of pipes and ditches. The DB discharges to the St. Clair River with other site wastewater in accordance with a National Pollution Discharge Elimination System (NPDES) permit.

1.3 Geology/Hydrogeology

The BRPP DB CCR unit is located approximately one-mile west of the St. Clair River. The BRPP DB CCR unit is underlain by more than 130 feet of unconsolidated sediments, with the lower confining Bedford Shale generally encountered from 135 to 145 feet below ground surface (bgs). In general, the BRPP DB CCR unit is underlain by at least 130 feet of laterally extensive low hydraulic conductivity silty clay-rich deposits. The silty clay-rich till was then underlain by two to seven feet of silt between the till and the underlying shale bedrock (not an aquifer) confining unit. Groundwater was encountered within this silt at the shale bedrock interface representing a potential confined uppermost aquifer in the BRPP DB CCR unit.

A definitive groundwater flow direction to the west-northwest with a mean gradient of 0.003 foot/foot within the uppermost aquifer is evident around the BRPP CCR DB CCR unit using data collected in 2016 through 2018; however, potential groundwater flow within this silt-rich uppermost aquifer is very slow (on the order of one-half foot per year).

In addition, the elevation of CCR-affected water maintained within the BRPP DB is approximately 5 feet above the potentiometric surface elevations in the uppermost aquifer at the DB CCR unit area. This suggests that if the CCR affected surface water in the DB were able to penetrate the silty clay-rich underlying confining unit, then the head on that release likely would travel radially away from the DB within the uppermost aquifer. However, with the very thick continuous silty clay-rich confining unit beneath the BRPP it is not possible for the uppermost aquifer to have been affected by CCR from BRPP operations that began in the 1980s.

Due to the relatively small footprint of the DB, the low vertical and horizontal groundwater flow velocity and radial flow potential outward from the CCR unit, and the fact that the uppermost saturated unit being monitored is isolated by a laterally contiguous silty-clay unit which significantly impedes vertical groundwater flow thus preventing the monitored saturated zone (identified as the potential uppermost aquifer) from potentially being affected by CCR, monitoring of the BRPP DB CCR unit using intrawell statistical methods is appropriate. As such, intrawell statistical approaches are being used during detection monitoring as discussed in the Stats Plan.

Section 2

Groundwater Monitoring

2.1 Monitoring Well Network

A groundwater monitoring system has been established for the BRPP DB CCR unit as detailed in the *Groundwater Monitoring System Summary Report – DTE Electric Company Belle River Power Plant Bottom Ash Basins and Diversion Basin Coal Combustion Residual Units* (GWMS Report) (TRC, October 2017). The detection monitoring well network for the DB CCR unit currently consists of six monitoring wells that are screened in the uppermost aquifer. The monitoring well locations are shown on Figure 2.

As discussed in the Stats Plan, intrawell statistical methods for the DB CCR unit were selected based on the geology and hydrogeology at the Site (primarily the presence of clay/hydraulic barrier, the relatively small footprint of the DB, combined with low vertical and horizontal groundwater flow velocity), in addition to other supporting lines of evidence that the aquifer is unaffected by the CCR unit (such as the consistency in concentrations of water quality data). An intrawell statistical approach requires that each of the downgradient wells doubles as a background and compliance well, where data from each individual well during a detection monitoring event is compared to a statistical limit developed using the background dataset from that same well. Monitoring wells MW-16-05 through MW-16-08, MW-16-10, and MW-16-11A are generally located around the east and west perimeter of the DB and provide data on both background and downgradient groundwater quality that has not been affected by the CCR unit (total of six background/downgradient monitoring wells).

Monitoring well MW-16-11 was found to be damaged in March 2017 and could no longer be used to obtain representative groundwater samples. A casing failure was suspected when grout was observed at the base of the well and confirmed using a downhole camera assessment that identified a crack in the casing 40 feet down. The monitoring well was properly decommissioned on May 11, 2017 and replaced on May 12, 2017, with monitoring well MW-16-11A. The replacement monitoring well is located proximal to MW-16-11 to the south and was installed utilizing procedures consistent with those described in the QAPP.

2.2 Semiannual Groundwater Monitoring

The semiannual monitoring parameters for the detection groundwater monitoring program were selected per the CCR Rule's Appendix III to Part 257 – Constituents for Detection Monitoring. The Appendix III indicator parameters consist of boron, calcium, chloride, fluoride, pH (field reading), sulfate, and total dissolved solids (TDS) and were analyzed in accordance with the

sampling and analysis plan included within the QAPP. In addition to pH, the collected field parameters included dissolved oxygen, oxidation reduction potential, specific conductivity, temperature, and turbidity.

2.2.1 Data Summary

The first semiannual groundwater detection monitoring event for 2019 was performed during March 18 through 20, 2019 by TRC personnel and samples were analyzed by TestAmerica in accordance with the QAPP. Static water elevation data were collected at all six monitoring well locations. Groundwater samples were collected from the six detection monitoring wells for the Appendix III indicator parameters and field parameters. A summary of the groundwater data collected during the March 2019 event is provided on Table 1 (static groundwater elevation data), Table 2 (field data), and Table 3 (analytical results).

The second semiannual groundwater detection monitoring event for 2019 was performed during September 16 and 17, 2019 by TRC personnel and samples were analyzed by TestAmerica in accordance with the QAPP. Static water elevation data were collected at all six monitoring well locations. Groundwater samples were collected from the six detection monitoring wells for the Appendix III indicator parameters and field parameters. A summary of the groundwater data collected during the September 2019 event is provided on Table 1 (static groundwater elevation data), Table 2 (field data), and Table 4 (analytical results).

2.2.2 Data Quality Review

Data from each round were evaluated for completeness, overall quality and usability, method-specified sample holding times, precision and accuracy, and potential sample contamination. The data were found to be complete and usable for the purposes of the CCR monitoring program. Data quality reviews are summarized in Appendix B.

2.2.3 Groundwater Flow Rate and Direction

The general flow rate and direction from both groundwater monitoring events are similar to that identified in previous monitoring rounds and continues to demonstrate that the downgradient wells are appropriately positioned to detect the presence of Appendix III parameters that could potentially migrate from the BRPP DB CCR unit. Groundwater elevation data collected during the March and September 2019 sampling events show that groundwater within the uppermost aquifer generally flows to the west-northwest across the BRPP DB, consistent with previous events. Groundwater potentiometric surface elevations measured across the BRPP DB during the March and

September 2019 sampling events are provided on Table 1 and were used to construct the groundwater potentiometric surface maps shown on Figures 3 and 4, respectively.

The average hydraulic gradient throughout the BRPP DB during both of the 2019 semiannual events is estimated at approximately 0.003 ft/ft, resulting in an estimated average seepage velocity of approximately 0.002 ft/day or 0.6 ft/year using the average hydraulic conductivity of 0.2 ft/day (TRC, 2017) and an assumed effective porosity of 0.4.

As presented in the GWMS Report, there is a horizontally expansive clay with substantial vertical thickness that isolates the uppermost aquifer from the BRPP DB CCR unit. The general flow direction in the uppermost aquifer is similar to that identified in previous monitoring rounds and continues to demonstrate that the compliance wells are appropriately positioned to detect the presence of Appendix III parameters that could potentially migrate from the BRPP DB CCR unit.

Section 3

Statistical Evaluation

3.1 Establishing Background Limits

Per the Stats Plan, background limits were established for the Appendix III indicator parameters following the collection of at least eight background monitoring events using data collected from each of the six established detection monitoring wells (MW-16-05 through MW-16-08, MW-16-10, and MW-16-11/11A). The statistical evaluation of the background data is presented in the 2017 Annual Report. The Appendix III background limits for each monitoring well will be used throughout the detection monitoring period to determine whether groundwater has been impacted from the BRPP DB CCR unit by comparing concentrations in the detection monitoring wells to their respective background limits for each Appendix III indicator parameter.

3.2 Data Comparison to Background Limits – First 2019 Semiannual Event (March 2019)

The concentrations of the indicator parameters in each of the detection monitoring wells (MW-16-05 through MW-16-08, MW-16-10, and MW-16-11A) were compared to their respective statistical background limits calculated from the background data collected from each individual well (i.e., monitoring data from MW-16-05 is compared to the background limit developed using the background dataset from MW-16-05, and so forth).

The comparisons of the March 2019 monitoring event data to background limits are presented in Table 3. The statistical evaluation of the March 2019 Appendix III indicator parameters showed potential initial SSIs over background for:

- Calcium at MW-16-10.

Verification resampling is recommended per the Stats Plan and the *USEPA's Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance* (USEPA, 2009) (Unified Guidance), to achieve performance standards as specified by §257.93(g) in the CCR rules. Per the Stats Plan, if there is an exceedance of a prediction limit for one or more of the parameters, the well(s) of concern will be resampled within 30 days of the completion of the initial statistical analysis. Constituents that have been addressed by an alternative source demonstration (ASD) will not be analyzed for verification purposes.

3.3 Verification Resampling for the First Semiannual Event

Verification resampling for the March 2019 event was conducted on May 8, 2019, by TRC personnel, in accordance with the QAPP. A summary of the groundwater data collected during

the verification resampling event is provided on Table 3. The associated data quality review is included in Appendix B.

The calcium verification result is below the prediction limit and no SSI will be recorded from the March 2019 detection monitoring event for this parameter in accordance with the Stats Plan and the Unified Guidance. As such, detection monitoring was continued in accordance with §257.94 of the CCR Rule.

3.4 Data Comparison to Background Limits – Second 2019 Semiannual Event (September 2019)

The comparisons of the September 2019 monitoring event data to background limits are presented in Table 4. The statistical evaluation of the March 2019 Appendix III indicator parameter data shows that there were no concentrations above background limits for any Appendix III indicator parameter during the second 2019 semiannual detection monitoring event.

Section 4

Conclusions and Recommendations

A potential SSI was noted for calcium at MW-16-10 during the March 2019 monitoring event. This potential SSI was not statistically significant (i.e. verification sampling did not confirm the exceedance). Therefore, no SSIs were recorded for the 2019 monitoring period and detection monitoring will be continued at the BRPP DB CCR unit in accordance with §257.94. As discussed above, and in the GWMS Report, with the presence of the vertically and horizontally extensive clay-rich confining till beneath the BRPP DB CCR unit, it is not possible for the uppermost aquifer to have been affected by CCR from operations. In addition, due to limitations on CCR Rule implementation timelines, the background data sets are of relatively short duration for capturing the occurrence of natural temporal changes in the aquifer. Therefore, detection monitoring will be continued at the BRPP DB CCR unit in accordance with §257.94.

No corrective actions were performed in 2019. The next semiannual monitoring event is scheduled for the second calendar quarter of 2020.

Section 5

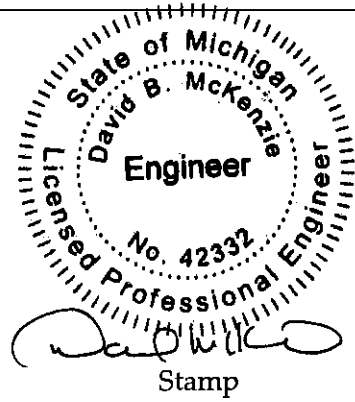
Groundwater Monitoring Report Certification

The U.S. EPA's Disposal of Coal Combustion Residuals from Electric Utilities Final Rule Title 40 CFR Part 257 §257.90(e) requires that the owner or operator of an existing CCR unit prepare an annual groundwater monitoring and corrective action report.

Annual Groundwater Monitoring Report Certification Belle River Power Plant Diversion Basin China Township, Michigan

CERTIFICATION

I hereby certify that the annual groundwater and corrective action report presented within this document for the BRPP DB CCR unit has been prepared to meet the requirements of Title 40 CFR §257.90(e) of the Federal CCR Rule. This document is accurate and has been prepared in accordance with good engineering practices, including the consideration of applicable industry standards, and with the requirements of Title 40 CFR §257.90(e).

Name: David B. McKenzie, P.E.	Expiration Date: October 31, 2021	
Company: TRC Engineers Michigan, Inc.	Date: January 30, 2020	

Section 6

References

- TRC Environmental Corporation. July 2016; Revised March and August 2017. CCR Groundwater Monitoring and Quality Assurance Project Plan – DTE Electric Company Belle River Power Plant Bottom Ash Basins and Diversion Basin, 4505 King Road, China Township, Michigan. Prepared for DTE Electric Company.
- TRC Environmental Corporation. October 2017. Groundwater Monitoring System Summary Report – DTE Electric Company Belle River Power Plant Bottom Ash Basins and Diversion Basin Coal Combustion Residual Units, 4505 King Road, China Township, Michigan. Prepared for DTE Electric Company.
- TRC Environmental Corporation. October 2017. Groundwater Statistical Evaluation Plan – DTE Electric Company Belle River Power Plant Coal Combustion Residual Diversion Basin, 4505 King Road, China Township, Michigan. Prepared for DTE Electric Company.
- TRC Environmental Corporation. January 2018. Annual Groundwater Monitoring Report – DTE Electric Company Belle River Power Plant Diversion Basin, 4505 King Road, China Township, Michigan. Prepared for DTE Electric Company.
- TRC Environmental Corporation. April 12, 2018. Alternate Source Demonstration: 2017 Initial Detection Monitoring Sampling Event Belle River Power Plant Coal Combustion Residual Diversion Basin. Prepared for DTE Electric Company.
- USEPA. 2009. Statistical Analysis of Groundwater Monitoring Data at RCRA facilities, Unified Guidance. Office of Conservation and Recovery. EPA 530/R-09-007.
- USEPA. April 2015. 40 CFR Parts 257 and 261. Hazardous and Solid Waste Management System: Disposal of Coal Combustion Residuals from Electric Utilities; Final Rule. 80 Federal Register 74 (April 17, 2015), pp. 21301-21501 (80 FR 21301).
- USEPA. July 2018. 40 CFR Part 257. Hazardous and Solid Waste Management System: Disposal of Coal Combustion Residuals from Electric Utilities; Amendments to the National Minimum Criteria (Phase One, Part One); Final Rule. 83 Federal Register 146 (July 30, 2018), pp. 36435-36456 (83 FR 36435).
- USEPA. April 2018. Barnes Johnson (Office of Resource Conservation and Recovery) to James Roewer (c/o Edison Electric Institute) and Douglas Green, Margaret Fawal (Venable LLP). Re: Coal Combustion Residuals Rule Groundwater Monitoring Requirements. April 30, 2018. United States Environmental Protection Agency, Washington, D.C. 20460. Office of Solid Waste and Emergency Response, now the Office of Land and Emergency Management.

Tables

Table 1
Summary of Groundwater Elevation Data – March and September 2019
Belle River Power Plant Diversion Basin – RCRA CCR Monitoring Program
China Township, Michigan

Well ID	MW-16-05		MW-16-06		MW-16-07		MW-16-08		MW-16-10		MW-16-11A	
Date Installed	3/4/2016		3/11/2016		3/9/2016		3/10/2016		6/6/2016		5/12/2017	
TOC Elevation	590.82		593.21		592.58		591.88		592.26		591.66	
Geologic Unit of Screened Interval	Clayey Silt/Shale Interface		Silt/Shale Interface		Silt/Shale Interface		Silt/Shale Interface		Gravely Silt and Silty Clay		Silt and Silty Clay	
Screened Interval Elevation	449.3 to 444.3		455.0 to 450.0		456.9 to 451.9		456.3 to 451.3		444.3 to 439.3		452.5 to 447.5	
Unit	ft BTOC	ft	ft BTOC	ft	ft BTOC	ft	ft BTOC	ft	ft BTOC	ft	ft BTOC	ft
Measurement Date	Depth to Water	GW Elevation	Depth to Water	GW Elevation	Depth to Water	GW Elevation	Depth to Water	GW Elevation	Depth to Water	GW Elevation	Depth to Water	GW Elevation
3/18/2019	16.73	574.09	17.50	575.71	16.60	575.98	16.52	575.36	17.71	574.55	16.77	574.89
9/16/2019	16.67	574.15	17.43	575.78	16.58	576.00	15.56	576.32	17.64	574.62	16.73	574.93

Notes:

Elevations are reported in feet relative to the North American Vertical Datum of 1988.

ft BTOC - feet Below top of casing.

Table 2
Summary of Field Data – March and September 2019
Belle River Power Plant Diversion Basin – RCRA CCR Monitoring Program
China Township, Michigan

Sample Location	Sample Date	Dissolved Oxygen (mg/L)	Oxidation Reduction Potential (mV)	pH (SU)	Specific Conductivity (umhos/cm)	Temperature (deg C)	Turbidity (NTU)
MW-16-05	3/18/2019	1.4	-203.6	8.0	4,948	9.60	20.6
	9/17/2019	0.39	-251.0	7.9	4,968	17.60	5.00
MW-16-06	3/20/2019	1.26	-226.5	8.0	4,586	11.10	3.71
	9/17/2019	0.19	119.3	8.1	4,683	15.56	4.52
MW-16-07	3/20/2019	1.10	-261.5	8.0	5,032	10.50	77.1
	9/17/2019	0.17	124.2	8.1	5,130	15.30	107.0
MW-16-08	3/19/2019	1.06	-162.5	8.1	4,990	10.80	87.0
	9/17/2019	0.17	34.6	8.2	5,243	12.76	127.0
MW-16-10	3/19/2019	1.09	-230.0	8.0	4,351	10.70	64.0
	9/17/2019	0.50	57.8	8.1	4,620	14.11	80.5
MW-16-11A	3/19/2019	1.15	-135.4	8.0	4,577	10.00	36.2
	9/17/2019	0.43	-170.1	8.1	5,446	12.50	3.98

Notes:

mg/L - milligrams per liter.

mV - milliVolt.

SU - standard unit.

umhos/cm - micro-mhos per centimeter.

deg C - degrees Celcius.

NTU - nephelometric turbidity units.

Table 3
Comparison of Appendix III Results to Background Limits – March and May 2019
Belle River Power Plant Diversion Basin – RCRA CCR Monitoring Program
China Township, Michigan

Sample Location: Sample Date:		MW-16-05		MW-16-06		MW-16-07		MW-16-08		MW-16-10			MW-16-11A	
		3/18/2019	PL	3/20/2019	PL	3/20/2019	PL	3/19/2019	PL	3/19/2019	5/8/2019 ⁽¹⁾	PL	3/19/2019	PL
Constituent	Unit	Data		Data		Data		Data		Data	Data		Data	
Appendix III														
Boron	ug/L	1,700	2,000	1,900	2,200	2,000	2,100	1,900	2,300	2,000	--	2,300	1,800	2,000
Calcium	ug/L	35,000	67,000	35,000	45,000	45,000	110,000	48,000	99,000	35,000	30,000	34,000	35,000	80,000
Chloride	mg/L	1,500	1,600	1,700	1,800	1,800	1,800	1,900	2,000	1,500	--	1,800	1,700	1,700
Fluoride	mg/L	1.1	1.3	1.1	1.3	1.0	1.2	1.1	1.3	0.96	--	1.2	0.91	1.0
pH, Field	SU	8.0	7.9 - 8.5	8.0	7.5 - 8.4	8.0	7.7 - 8.4	8.1	7.5 - 8.3	8.0	8.1	7.5 - 8.8	8.0	7.6 - 8.6
Sulfate	mg/L	16	20	3.8	20	68	98	2.8	23	140	--	160	2.5	20
Total Dissolved Solids	mg/L	2,600	2,700	2,600	3,000	3,000	3,400	3,100	3,200	2,700	--	3,100	2,900	3,000

Notes:

ug/L - micrograms per liter.

mg/L - milligrams per liter.

SU - standard units; pH is a field parameter.

All metals were analyzed as total unless otherwise specified.

Bold font indicates an exceedance of the Prediction Limit (PL).

(1) - Results shown for verification sampling performed on 5/8/2019.

Table 4
Comparison of Appendix III Results to Background Limits – September 2019
Belle River Power Plant Diversion Basin – RCRA CCR Monitoring Program
China Township, Michigan

Sample Location:		MW-16-05		MW-16-06		MW-16-07		MW-16-08		MW-16-10		MW-16-11A	
Sample Date:		9/17/2019	PL	9/17/2019	PL	9/17/2019	PL	9/17/2019	PL	9/17/2019	PL	9/17/2019	PL
Constituent	Unit	Data		Data		Data		Data		Data		Data	
Appendix III													
Boron	ug/L	1,800	2,000	1,900	2,200	2,000	2,100	1,700	2,300	2,000	2,300	1,700	2,000
Calcium	ug/L	38,000	67,000	40,000	45,000	50,000	110,000	55,000	99,000	29,000	34,000	41,000	80,000
Chloride	mg/L	1,400	1,600	1,500	1,800	1,700	1,800	1,800	2,000	1,500	1,800	1,600	1,700
Fluoride	mg/L	1.1	1.3	1.0	1.3	1.1	1.2	1.1	1.3	1.0	1.2	0.94	1.0
pH, Field	SU	7.9	7.9 - 8.5	8.1	7.5 - 8.4	8.1	7.7 - 8.4	8.2	7.5 - 8.3	8.1	7.5 - 8.8	8.1	7.6 - 8.6
Sulfate	mg/L	15	20	< 5.0	20	67	98	< 5.0	23	57	160	< 5.0	20
Total Dissolved Solids	mg/L	2,500	2,700	2,800	3,000	2,900	3,400	3,000	3,200	2,900	3,100	2,500	3,000

Notes:

ug/L - micrograms per liter.

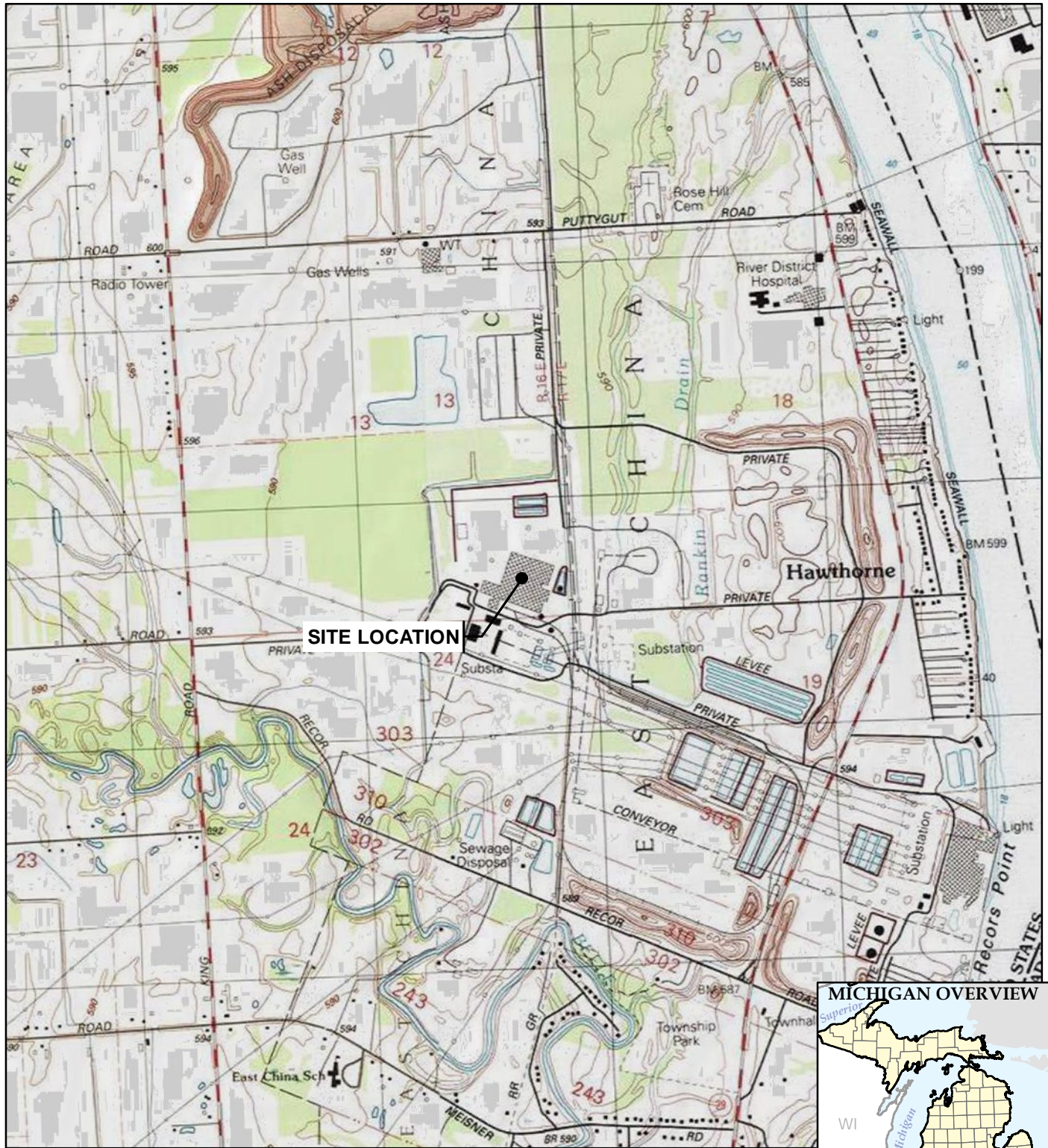
mg/L - milligrams per liter.

SU - standard units; pH is a field parameter.

All metals were analyzed as total unless otherwise specified.

Bold font indicates an exceedance of the Prediction Limit (PL).

Figures



BASE MAP FROM USGS 7.5 MINUTE TOPOGRAPHIC QUADRANGLE SERIES.



1540 Eisenhower Place
Ann Arbor, MI 48108-3284
Phone: 734.971.7080
www.trccompanies.com

TRC - GIS

PROJECT:

**DTE ELECTRIC COMPANY
BELLE RIVER POWER PLANT
4505 KING ROAD
CHINA TOWNSHIP, MICHIGAN**

TITLE:

SITE LOCATION MAP

DRAWN BY:

S. MAJOR

CHECKED BY:

J. KRENZ

APPROVED BY:

V. BUENING

DATE:

JANUARY 2020

PROJ. NO.:

320511.0003




FILE:

320511-0003-003slmMB.mxd

FIGURE 1

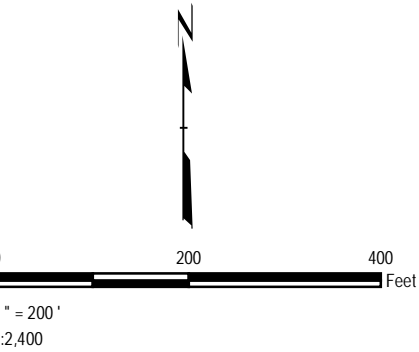



LEGEND

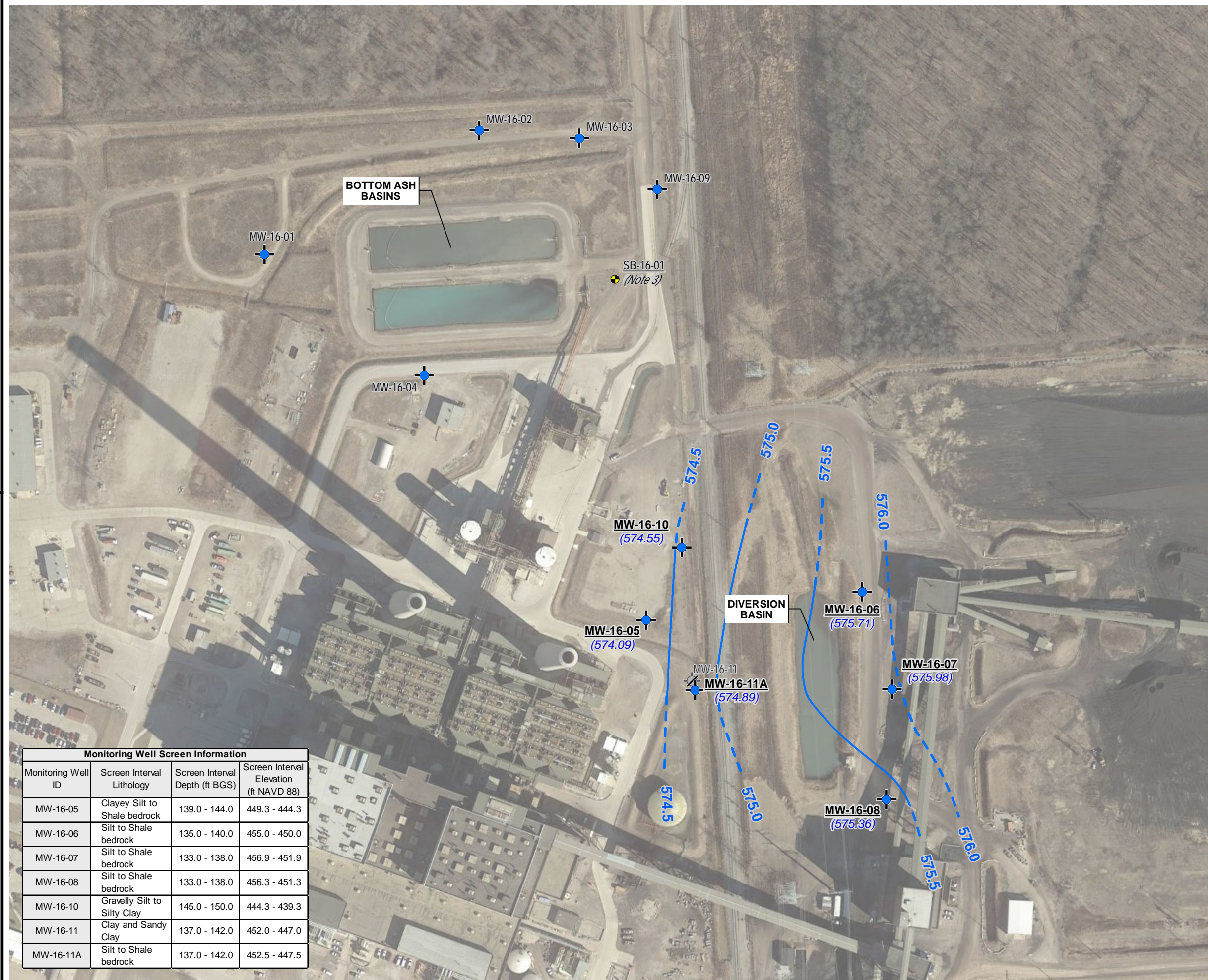
-  SOIL BORING
-  MONITORING WELL
-  DECOMMISSIONED MONITORING WELL

NOTES

1. BASE MAP IMAGERY FROM GOOGLE EARTH PRO. & PARTNERS, (3/24/2019).
2. WELL LOCATIONS SURVEYED IN MARCH, APRIL, JUNE 2016, AND JUNE 2017 BY BMJ ENGINEERS & SURVEYORS, INC.



PROJECT:		DTE ELECTRIC COMPANY BELLE RIVER POWER PLANT DIVERSION BASIN 4505 KING ROAD CHINA TOWNSHIP, MICHIGAN	
TITLE:		SITE PLAN	
DRAWN BY:	M. VAPHIADIS	PROJ NO.:	320511.0003.0000 P1 T1
CHECKED BY:	J. KRENZ	FIGURE 2	
APPROVED BY:	V. BUENING		
DATE:	JANUARY 2020		
		1540 Eisenhower Place Ann Arbor, MI 48108-3284 Phone: 734.971.7080 www.trccompanies.com	
FILE NO.:		320511-0003-025.mxd	



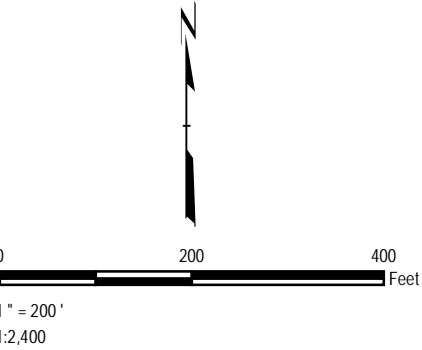
Monitoring Well Screen Information			
Monitoring Well ID	Screen Interval Lithology	Screen Interval Depth (ft BGS)	Screen Interval Elevation (ft NAVD 88)
MW-16-05	Clayey Silt to Shale bedrock	139.0 - 144.0	449.3 - 444.3
MW-16-06	Silt to Shale bedrock	135.0 - 140.0	455.0 - 450.0
MW-16-07	Silt to Shale bedrock	133.0 - 138.0	456.9 - 451.9
MW-16-08	Silt to Shale bedrock	133.0 - 138.0	456.3 - 451.3
MW-16-10	Gravelly Silt to Silty Clay	145.0 - 150.0	444.3 - 439.3
MW-16-11	Clay and Sandy Clay	137.0 - 142.0	452.0 - 447.0
MW-16-11A	Silt to Shale bedrock	137.0 - 142.0	452.5 - 447.5

LEGEND

- SOIL BORING
- MONITORING WELL
- DECOMMISSIONED MONITORING WELL
- (575.47) GROUNDWATER ELEVATION (FT NAVD 88)
- GROUNDWATER ELEVATION CONTOUR (0.5-FT INTERVAL, DASHED WHERE INFERRED)

NOTES

1. BASE MAP IMAGERY FROM GOOGLE EARTH PRO, (3/24/2019).
2. WELL LOCATIONS SURVEYED IN MARCH, APRIL, AND JUNE 2016 BY BMJ ENGINEERS AND SURVEYORS. INC.
3. NO SAND OR GRAVEL UNIT PRESENT ABOVE BEDROCK IN THIS LOCATION.
4. GROUNDWATER ELEVATIONS DISPLAYED IN FEET RELATIVE TO NORTH AMERICAN VERTICAL DATUM OF 1988.



PROJECT:

DTE ELECTRIC COMPANY
BELLE RIVER POWER PLANT DIVERSION BASIN
4505 KING ROAD
CHINA TOWNSHIP, MICHIGAN

TITLE:

DIVERSION BASIN GROUNDWATER
POTENTIOMETRIC SURFACE MAP
MARCH 2019

DRAWN BY:

M. VAPHIADIS

PROJ NO.:

320511.0003

CHECKED BY:

J. KRENZ

APPROVED BY:

V. BUENING

DATE:

JANUARY 2020

FIGURE 3

1540 Eisenhower Place
Ann Arbor, MI 48108-3284
Phone: 734.971.7080
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FILE NO.:

320511-0003-026.mxd



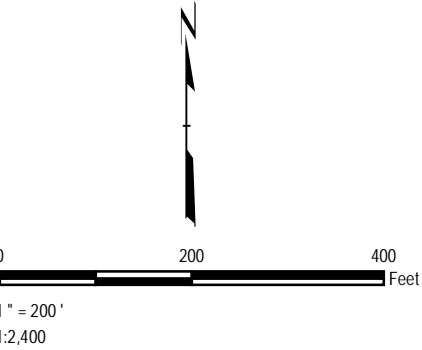
Monitoring Well Screen Information			
Monitoring Well ID	Screen Interval Lithology	Screen Interval Depth (ft BGS)	Screen Interval Elevation (ft NAVD 88)
MW-16-05	Clayey Silt to Shale bedrock	139.0 - 144.0	449.3 - 444.3
MW-16-06	Silt to Shale bedrock	135.0 - 140.0	455.0 - 450.0
MW-16-07	Silt to Shale bedrock	133.0 - 138.0	456.9 - 451.9
MW-16-08	Silt to Shale bedrock	133.0 - 138.0	456.3 - 451.3
MW-16-10	Gravelly Silt to Silty Clay	145.0 - 150.0	444.3 - 439.3
MW-16-11	Clay and Sandy Clay	137.0 - 142.0	452.0 - 447.0
MW-16-11A	Silt to Shale bedrock	137.0 - 142.0	452.5 - 447.5

LEGEND

- SOIL BORING
- MONITORING WELL
- DECOMMISSIONED MONITORING
- GROUNDWATER ELEVATION (FT NAVD 88)
- GROUNDWATER ELEVATION CONTOUR (0.5-FT INTERVAL, DASHED WHERE INFERRED)

NOTES

- BASE MAP IMAGERY FROM GOOGLE EARTH PRO, (3/24/2019).
- WELL LOCATIONS SURVEYED IN MARCH, APRIL, AND JUNE 2016 BY BMJ ENGINEERS AND SURVEYORS. INC.
- NO SAND OR GRAVEL UNIT PRESENT ABOVE BEDROCK IN THIS LOCATION.
- GROUNDWATER ELEVATIONS DISPLAYED IN FEET RELATIVE TO NORTH AMERICAN VERTICAL DATUM OF 1988.



PROJECT:		DTE ELECTRIC COMPANY BELLE RIVER POWER PLANT DIVERSION BASIN 4505 KING ROAD CHINA TOWNSHIP, MICHIGAN	
TITLE:		DIVERSION BASIN GROUNDWATER POTENTIOMETRIC SURFACE MAP SEPTEMBER 2019	
DRAWN BY:	M. VAPHIADIS	PROJ NO.:	320511.0003
CHECKED BY:	J. KRENZ	FIGURE 4	
APPROVED BY:	V. BUENING		
DATE:	JANUARY 2020		
		1540 Eisenhower Place Ann Arbor, MI 48108-3284 Phone: 734.971.7080 www.trccompanies.com	
FILE NO.:		320511-0003-028.mxd	

Appendix A

Data Quality Reviews

Laboratory Data Quality Review

Groundwater Monitoring Event March 2019 (Detection Monitoring)

DTE Electric Company Belle River Power Plant (DTE BRPP)

Groundwater samples were collected by TRC for the March 2019 sampling event for the Diversion Basin at the DTE BRPP. Samples were analyzed for anions, boron, calcium, and total dissolved solids by Test America Laboratories, Inc., (Test America) located in North Canton, Ohio. The laboratory analytical results are reported in laboratory report 240-109798-1.

During the March 2019 sampling event, a groundwater sample was collected from the following wells:

- MW-16-01
- MW-16-02
- MW-16-03
- MW-16-04
- MW-16-05
- MW-16-06
- MW-16-07
- MW-16-08
- MW-16-09
- MW-16-10
- MW-16-11A

Each sample was analyzed for the following constituents:

Analyte Group	Method
Anions (Chloride, Fluoride, Sulfate)	SW846 9056A
Total Boron	SW846 3005A/6010B
Total Calcium	SW846 3005A/6020
Total Dissolved Solids	SM 2540C

TRC reviewed the laboratory data to assess data usability. The following sections summarize the data review procedure and the results of the review.

Data Quality Review Procedure

The analytical data were reviewed using the USEPA National Functional Guidelines for Inorganic Superfund Data Review (USEPA, 2017). The following items were included in the evaluation of the data:

- Sample receipt, as noted in the cover page or case narrative;
- Technical holding times for analyses;
- Reporting limits (RLs) compared to project-required RLs;
- Data for method blanks and equipment blanks. Method blanks are used to assess potential contamination arising from laboratory sample preparation and/or analytical procedures. Equipment blanks are used to assess potential contamination arising from field procedures;

- Data for laboratory control samples (LCSs). The LCSs are used to assess the accuracy of the analytical method using a clean matrix;
- Data for matrix spike and matrix spike duplicate samples (MS/MSDs), if applicable. The MS/MSDs are used to assess the accuracy and precision of the analytical method using a sample from the dataset;
- Data for laboratory duplicates, if applicable. The laboratory duplicates are used to assess the precision of the analytical method using a sample from the dataset;
- Data for blind field duplicates. Field duplicate samples are used to assess variability introduced by the sampling and analytical processes; and
- Overall usability of the data.

This data usability report addresses the following items:

- Usability of the data if quality control (QC) results suggest potential problems with all or some of the data;
- Actions regarding specific QC criteria exceedances.

Review Summary

The data quality objectives and laboratory completeness goals for the project were met, and the data are usable for their intended purpose. A summary of the data quality review, including non-conformances and issues identified in this evaluation are noted below.

- The reviewed constituents will be utilized for the purposes of a detection monitoring program.
- Data are usable for the purposes of the detection monitoring program.

QA/QC Sample Summary:

- The holding time for TDS for samples MW-16-01, MW-16-02, MW-16-03, MW-16-04, MW-16-05, DUP-01, and EB-01 exceeded the 7-day holding time criteria by approximately 5-10 hours. These results are estimated and may be biased low.
- Target analytes were not detected in the equipment blank (EB-01_20190318).
- Target analytes were not detected in the method blanks.
- LCS recoveries for all target analytes were within laboratory control limits.
- Sample DUP-01 corresponds with sample MW-16-01. The relative percent differences (RPDs) between the parent and duplicate sample were within the acceptance limits.
- Laboratory duplicate analyses were performed on sample MW-16-01 for TDS; the RPD was within the acceptance limits.

- MS/MSD analyses were performed on the following samples:
 - Sample MW-16-01 for boron; the percent recoveries (%Rs) and RPDs were within the acceptance limits.
 - Samples MW-16-02 and DUP-01 for fluoride and sulfate; the %Rs and RPDs were within the acceptance limits.
 - Sample MW-16-02 for calcium; the MS/MSD %Rs (68%/63%) were below the lower QC limit of 75%, but no action was required since the sample result in the parent sample was > 4x the spike added.
- For TDS, the constant weight was not achieved after three drying cycles for sample MW-16-02; there was no impact on data usability.

**Laboratory Data Quality Review
Groundwater Monitoring Event
May 2019 Verification (Detection Monitoring)
DTE Electric Company Belle River Power Plant (DTE BRPP)**

Groundwater samples were collected by TRC for the May 2019 verification sampling event for the Diversion Basin at the DTE BRPP. Samples were analyzed for anions, boron, calcium, and total dissolved solids by Test America Laboratories, Inc., (Test America) located in North Canton, Ohio. The laboratory analytical results are reported in laboratory report 240-109798-1.

During the May 2019 sampling event, a groundwater sample was collected from the following wells:

- MW-16-01
- MW-16-04
- MW-16-10

Each sample was analyzed for the following constituents:

Analyte Group	Method
Anions (Chloride, Fluoride, Sulfate)	SW846 9056A
Total Calcium	SW846 3005A/6020
Total Dissolved Solids	SM 2540C

TRC reviewed the laboratory data to assess data usability. The following sections summarize the data review procedure and the results of the review.

Data Quality Review Procedure

The analytical data were reviewed using the USEPA National Functional Guidelines for Inorganic Superfund Data Review (USEPA, 2017). The following items were included in the evaluation of the data:

- Sample receipt, as noted in the cover page or case narrative;
- Technical holding times for analyses;
- Reporting limits (RLs) compared to project-required RLs;
- Data for method blanks and equipment blanks. Method blanks are used to assess potential contamination arising from laboratory sample preparation and/or analytical procedures. Equipment blanks are used to assess potential contamination arising from field procedures;
- Data for laboratory control samples (LCSs). The LCSs are used to assess the accuracy of the analytical method using a clean matrix;

- Data for matrix spike and matrix spike duplicate samples (MS/MSDs), if applicable. The MS/MSDs are used to assess the accuracy and precision of the analytical method using a sample from the dataset;
- Data for laboratory duplicates, if applicable. The laboratory duplicates are used to assess the precision of the analytical method using a sample from the dataset;
- Data for blind field duplicates. Field duplicate samples are used to assess variability introduced by the sampling and analytical processes; and
- Overall usability of the data.

This data usability report addresses the following items:

- Usability of the data if quality control (QC) results suggest potential problems with all or some of the data;
- Actions regarding specific QC criteria exceedances.

Review Summary

The data quality objectives and laboratory completeness goals for the project were met, and the data are usable for their intended purpose. A summary of the data quality review, including non-conformances and issues identified in this evaluation are noted below.

- The reviewed constituents will be utilized for the purposes of a detection monitoring program.
- Data are usable for the purposes of the detection monitoring program.

QA/QC Sample Summary:

- All holding times were met for the methods performed on these samples.
- Target analytes were not detected in the equipment blank (EB-01).
- Target analytes were not detected in the method blanks.
- LCS recoveries for all target analytes were within laboratory control limits.
- The field duplicate pair samples were DUP-01 and MW-16-01, DUP-02 and MW-16-04, and DUP-03 and MW-16-10. The relative percent differences (RPDs) between the parent and duplicate samples were within the acceptance limits.
- For TDS, the laboratory reporting limit did not meet the specified limit in the QAPP; however, TDS was detected in the sample (MW-16-01). Therefore, there was no impact on data usability.

Laboratory Data Quality Review

Groundwater Monitoring Event September 2019 (Detection Monitoring)

DTE Electric Company Belle River Power Plant (DTE BRPP)

Groundwater samples were collected by TRC for the September 2019 sampling event for the Bottom Ash Basins and Diversion Basin at the DTE BRPP. Samples were analyzed for anions, total boron, total calcium, and total dissolved solids by Eurofins-Test America Laboratories, Inc. (Eurofins-TA), located in North Canton, Ohio. The laboratory analytical results are reported in laboratory report 240-119135-1.

During the September 2019 sampling event, a groundwater sample was collected from each of the following wells:

Bottom Ash Basins:

- MW-16-01
- MW-16-02
- MW-16-03
- MW-16-04
- MW-16-09

Diversion Basin:

- MW-16-05
- MW-16-06
- MW-16-07
- MW-16-08
- MW-16-10
- MW-16-11A

Each sample was analyzed for the following constituents:

Analyte Group	Method
Anions (Chloride, Fluoride, Sulfate)	SW846 9056A
Total Boron	SW846 3005A/6010B
Total Calcium	SW846 3005A/6020
Total Dissolved Solids	SM 2540C

TRC reviewed the laboratory data to assess data usability. The following sections summarize the data review procedure and the results of the review.

The analytical data were reviewed using the USEPA National Functional Guidelines for Inorganic Superfund Data Review (USEPA, 2017). The following items were included in the evaluation of the data:

- Sample receipt, as noted in the cover page or case narrative;
- Technical holding times for analyses;
- Reporting limits (RLs) compared to project-required RLs;

- Data for method blanks and equipment blanks, where applicable. Method blanks are used to assess potential contamination arising from laboratory sample preparation and/or analytical procedures. Equipment blanks are used to assess potential contamination arising from field procedures;
- Data for laboratory control samples (LCSs). The LCSs are used to assess the accuracy of the analytical method using a clean matrix;
- Data for matrix spike and matrix spike duplicate samples (MS/MSDs), where applicable. The MS/MSDs are used to assess the accuracy and precision of the analytical method using a sample from the dataset;
- Data for laboratory duplicates, where applicable. The laboratory duplicates are used to assess the precision of the analytical method using a sample from the dataset;
- Data for blind field duplicates. Field duplicate samples are used to assess variability introduced by the sampling and analytical processes; and
- Overall usability of the data.

This data usability report addresses the following items:

- Usability of the data if quality control (QC) results suggest potential problems with all or some of the data;
- Actions regarding specific QC criteria exceedances.

Review Summary

The data quality objectives and laboratory completeness goals for the project were met, and the data are usable for their intended purpose. A summary of the data quality review, including non-conformances and issues identified in this evaluation are noted below.

- Appendix III constituents will be utilized for the purposes of a detection monitoring program.
- Data are usable for the purposes of the detection monitoring program.

QA/QC Sample Summary:

- There was one equipment blank submitted with this dataset (EB-01) which was associated with the low hydraulic conductivity wells (MW-16-08, MW 16-10, and MW-16-11A). Chloride was detected at 1.8 mg/L and TDS was detected at 12 mg/L in this equipment blank. However, these analytes were detected at concentrations greater than five times the blank concentrations in the associated wells; thus, there was no impact on data usability.
- Target analytes were not detected in the method blanks.

- LCS recoveries for all target analytes were within laboratory control limits.
- MS/MSD analyses were performed on samples MW-16-01 for boron, MW-16-03 for fluoride and sulfate, and MW-16-02 for calcium; the percent recoveries (%Rs) and relative percent differences (RPDs) were acceptable.
 - MS/MSD analyses were not performed for chloride; per the project QAPP, MS/MSD analyses are required for chloride at a frequency of 1 per 20 samples. It is likely that an MS/MSD was performed on sample MW-16-03 for chloride but not reported by the laboratory since the sample was re-analyzed at a dilution for chloride.
- Laboratory duplicate analyses were not performed for TDS. Per the project QAPP, laboratory duplicate analyses are required for TDS at a frequency of 1 per 20 samples.
- Dup-01 corresponds with MW-16-01; RPDs between the parent and duplicate sample were within the QC limits.
- The nondetect reporting limits (5.0 mg/L) for sulfate in samples MW-16-06, MW-16-08, and MW-16-11A were above the QAPP-specified RL (1.0 mg/L) due to a 5-fold dilution which was likely the result of elevated chloride concentrations.

Appendix B

Owner Certification of Compliance



**Owner Certification of Site Compliance per 40 CFR 257 Subpart D
Belle River Power Plant Diversion Basin
China Township, Michigan**

The United States Environmental Protection Agency (EPA) Hazardous and Solid Waste Management System: Disposal of Coal Combustion Residuals From Electric Utilities; A Holistic Approach to Closure Part B: Alternate Demonstration for Unlined Surface Impoundments (40 CFR §257.71(d)), requires that the owner of an existing CCR unit certify the facility is in compliance with the requirements of the CCR Rules (40 CFR 257 Subpart D) except for §257.71(a)(1).

CERTIFICATION

Based on our review of the CCR Rules, I hereby certify that the subject facility is in compliance with the requirements of 40 CFR 257 Subpart D except for §257.71(a)(1).

SIGNATURE

DATE

PRINT NAME

TITLE

COMPANY NAME

Appendix C

Well Construction Diagrams and Soil Boring Logs

DRAFT





WELL CONSTRUCTION LOG

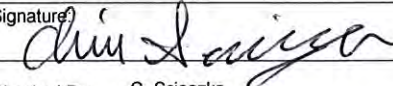
WELL NO. MW-16-01

Page 1 of 2

Facility/Project Name: DTE Electric Company Belle River Power Plant		Date Drilling Started: 2/29/16		Date Drilling Completed: 2/29/16		Project Number: 231828.0003					
Drilling Firm: Stock Drilling		Drilling Method: Sonic		Surface Elev. (ft) 588.17		TOC Elevation (ft) 591.30		Total Depth (ft bgs) 120.0		Borehole Dia. (in) 6/4	
Boring Location: Approximately 188 feet off road to the S, W of bottom ash basins. N: 471155.70 E: 13625546.02				Personnel Logged By - A. Knutson Driller - A. Goldsmith				Drilling Equipment: TSi 150cc			
Civil Town/City/or Village: China Township		County: St. Clair		State: MI		Water Level Observations: While Drilling: Date/Time After Drilling: Date/Time 4/13/16 08:45				Depth (ft bgs) 14.52	

SAMPLE		BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
NUMBER AND TYPE	RECOVERY (%)							
1 CS	60		5	SILTY CLAY WITH GRAVEL mostly clay, little to some silt, little fine to coarse gravel, few fine sand, low plasticity, dark gray (10YR 4/1), moist, medium stiff. CLAY mostly clay, trace fine to coarse gravel, high plasticity, brown (10YR 5/3), moist, stiff. Change to dark gray (10YR 4/1), very stiff at 5.0 feet. Change to soft at 8.0 feet. Change to no gravel, dark gray (10YR 4/1) mottled with brown (10YR 5/3), very soft at 10.0 feet.	CL-ML			Continuous sampling with 4-inch diameter casing from ground surface to terminus of soil boring, over-drilled with 6-inch diameter casing to install monitoring well. Original boring abandoned due to compromised screen. Redrilled and installed at survey location noted above within 10 feet of original location.
2 CS	50		15					
3 CS	100		25	Change to dark gray (10YR 4/1) at 20.0 feet.	CL			
4 CS	100		35					
			40					

SOIL BORING WELL CONSTRUCTION LOG 231828.0003.GPJ TRC CORP.GDT 7/14/16

Signature: Firm: TRC Environmental Corporation 734.971.7080
1540 Eisenhower Place Ann Arbor, Michigan Fax 734.971.9022

Checked By: C. Scieszka







WELL CONSTRUCTION LOG

WELL NO. MW-16-01

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SOIL BORING WELL CONSTRUCTION LOG 231828.0003.0000.GPJ TRC CORP.GDT 7/14/16

SAMPLE		BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
NUMBER AND TYPE	RECOVERY (%)							
5 CS	100		45	CLAY mostly clay, high plasticity, dark gray (10YR 4/1), moist, soft.	CL			
6 ST	100		50					
7 CS	100		55					
8 CS	80		65					
9 CS	100		75					
10 CS	100		85	SAND mostly fine sand, dark gray (10YR 4/1), saturated.	SP			
11 CS	100		95					
			100	End of boring at 100.0 feet below ground surface.				



WELL CONSTRUCTION LOG

WELL NO. MW-16-02

Page 1 of 2

Facility/Project Name: DTE Electric Company Belle River Power Plant		Date Drilling Started: 3/14/16		Date Drilling Completed: 3/15/16		Project Number: 231828.0003					
Drilling Firm: Stock Drilling		Drilling Method: Sonic		Surface Elev. (ft) 586.27		TOC Elevation (ft) 588.94		Total Depth (ft bgs) 100.0		Borehole Dia. (in) 6/4	
Boring Location: 325 feet W of haul road, 5 feet N of road, N of bottom ash basins. N: 471409.06 E: 13625991.78				Personnel Logged By - A. Knutson Driller - A. Goldsmith				Drilling Equipment: TSi 150cc			
Civil Town/City/or Village: China Township		County: St. Clair		State: MI		Water Level Observations: While Drilling: Date/Time After Drilling: Date/Time 4/13/16 09:24				Depth (ft bgs) 16.07	

SAMPLE		BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
NUMBER AND TYPE	RECOVERY (%)							
1 CS	80		5	CLAY mostly clay, few silt, few coarse gravel, medium plasticity, dark gray (10YR 4/1) mottled with brown (10YR 5/3), stiff.				Continuous sampling with 4-inch diameter casing from ground surface to terminus of soil boring, over-drilled with 6-inch diameter casing to install monitoring well.
			10	Change to no gravel at 7.0 feet.				
2 CS	80		15	Change to high plasticity, dark gray (10YR 4/1), moist, very soft at 10.0 feet.				
			20					
3 CS	100		25					
			30					
4 CS	90		35					
			40					

SOIL BORING WELL CONSTRUCTION LOG 231828.0003.0000.GPJ TRC CORP.GDT 7/14/16

Signature:

Firm: TRC Environmental Corporation
1540 Eisenhower Place Ann Arbor, Michigan734.971.7080
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Checked By: C. Scieszka



WELL CONSTRUCTION LOG

WELL NO. MW-16-02

Page 2 of 2

SAMPLE		BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
NUMBER AND TYPE	RECOVERY (%)							
5 CS	100		45	CLAY mostly clay, few silt, few coarse gravel, high plasticity, dark gray (10YR 4/1), moist, very soft.	CL			
6 CS	100		50	SILTY CLAY mostly clay, little to some silt, few fine sand, few fine to coarse gravel, high plasticity, dark gray (10YR 4/1), very soft.				
7 CS	50		55					
8 CS	100		60					
9 CS	100		65					
10 CS	100		70					
			75					
			80					
			85					
			90	CLAYEY SILT mostly silt, some clay, few fine sand, few coarse gravel, low plasticity, dark gray (10YR 4/1), moist, very soft.	ML-CL			
			95	SAND mostly fine to coarse sand, dark gray (10YR 4/1), saturated.				
			96	Change to fine sand at 96.0 feet.	SW			
			100	End of boring at 100.0 feet below ground surface.				

SOIL BORING WELL CONSTRUCTION LOG 231828.0003.0000.GPJ TRC CORP.GDT 7/14/16



WELL CONSTRUCTION LOG

WELL NO. MW-16-03

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Facility/Project Name: DTE Electric Company Belle River Power Plant		Date Drilling Started: 5/25/16		Date Drilling Completed: 5/31/16		Project Number: 231828.0003					
Drilling Firm: Stock Drilling		Drilling Method: Sonic		Surface Elev. (ft) 588.03		TOC Elevation (ft) 590.66		Total Depth (ft bgs) 150.0		Borehole Dia. (in) 6/4	
Boring Location: Approximately 100 feet W of haul road, N of bottom ash basins. N: 471391.78 E: 13626202.49				Personnel Logged By - J. Reed Driller - A. Goldsmith				Drilling Equipment: TSi 150cc			
Civil Town/City/or Village: China Township		County: St. Clair		State: MI		Water Level Observations: While Drilling: Date/Time After Drilling: Date/Time 6/8/16 14:30				Depth (ft bgs) 12.82	

SAMPLE		BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
NUMBER AND TYPE	RECOVERY (%)							
1 CS	100		5	TOPSOIL SILTY CLAY mostly clay, some silt, few fine to medium sand, trace gravel, low to medium plasticity, dark gray (10YR 4/1) with trace orange mottling, moist, medium stiff to stiff.	CL-ML			Continuous sampling with 4-inch diameter casing from ground surface to terminus of soil boring, over-drilled with 6-inch diameter casing to install monitoring well.
2 CS	100		10	Change to gray (10YR 5/1) at 10.5 feet. CLAY mostly clay, few silt, trace to few fine to medium sand, medium plasticity, gray (10YR 5/1), moist, soft to medium stiff.				
3 CS	100		25	Change to trace to few fine to coarse sand at 25.0 feet.	CL			
4 CS	100		35	Change to trace fine to coarse sand at 41.5 feet.				

SOIL BORING WELL CONSTRUCTION LOG 231828.0003.0000.GPJ TRC CORP.GDT 7/14/16

Signature:

Firm: TRC Environmental Corporation
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Checked By: M. Powers



WELL CONSTRUCTION LOG

WELL NO. MW-16-03

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SAMPLE		BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
NUMBER AND TYPE	RECOVERY (%)							
5 CS	100		45	CLAY mostly clay, few silt, trace fine to coarse sand, medium plasticity, gray (10YR 5/1), moist, soft to medium stiff.				
			50					
6 CS	90		55		CL			
			60	Change to stiff at 60.5 feet. Change to medium stiff at 62.0 feet.				
7 CS	100		65	SANDY CLAY mostly clay, little to some sand, few silt, gray (10YR 5/1), moist, soft to medium stiff.	CL			
			70	CLAY mostly clay, few silt, few fine to coarse sand, gray (10YR 5/1), moist, stiff. Change to coal fragments present at 67.5 feet. Change to no coal fragments present at 68.0 feet.	CL			
8 CS	90		75	1-inch thick interval of silty fine to coarse sand at 75.0 feet.				
			80	SANDY SILT mostly silt, little to some fine to medium sand, gray (10YR 5/1), moist, medium dense.	ML			
			85	CLAY mostly clay, few silt, few fine to coarse sand, low to medium plasticity, gray (10YR 5/1), moist, stiff.				
9 CS	100		90	Change to medium soft at 90.0 feet.	CL			
			95	Change to few fine gravel from 94.0 to 95.0 feet. Change to trace fine gravel, medium stiff to stiff at 95.0 feet.				
10 CS	100		100					



WELL CONSTRUCTION LOG

WELL NO. MW-16-03

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SAMPLE		BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
NUMBER AND TYPE	RECOVERY (%)							
11 CS	100		105	CLAY mostly clay, few silt, few fine to coarse sand, trace fine gravel, medium plasticity, gray (10YR 5/1), medium stiff to stiff.				
			110	Change to low plasticity, soft to medium stiff at 111.0 feet.				
12 CS	100		115		CL			
			120					
13 CS	100		125					
			130	SANDY CLAY mostly clay, little to some fine to medium sand, few silt, trace to few fine gravel, low to medium plasticity, gray (10YR 5/1), moist, medium stiff. SILTY SAND mostly fine to medium sand, little silt, gray (10YR 5/1), moist, loose.	CL SM			
14 CS	90		135	SAND mostly fine to medium sand, trace silt, gray (10YR 5/1), moist, loose.	SP			
			140	SILTY SAND mostly fine to medium sand, little silt, few clay, gray (10YR 5/1), moist, loose.	SM			
15 CS	100		145	SAND mostly fine to coarse sand, trace to few silt, trace to few clay, dark gray (10YR 4/1), moist to wet, loose.	SW			
			150	SILT mostly silt, few clay, trace coarse sand to fine gravel, gray (10YR 5/1), dry to moist, dense to very dense. SHALE weathered shale bedrock, dark gray. End of boring at 150 feet below ground surface.	ML			
			155					



WELL CONSTRUCTION LOG

WELL NO. MW-16-04

Page 1 of 3

Facility/Project Name: DTE Electric Company Belle River Power Plant		Date Drilling Started: 3/7/16		Date Drilling Completed: 3/8/16		Project Number: 231828.0003	
Drilling Firm: Stock Drilling		Drilling Method: Sonic		Surface Elev. (ft) 587.50		TOC Elevation (ft) 590.51	
Total Depth (ft bgs) 130.0		Borehole Dia. (in) 6/4		Boring Location: 200 feet from W corner of road, S of bottom ash basins. N: 470893.74 E: 13625876.34			
Personnel Logged By - A. Knutson Driller - A. Goldsmith				Drilling Equipment: TSi 150cc			
Civil Town/City/or Village: China Township		County: St. Clair		State: MI		Water Level Observations: While Drilling: Date/Time After Drilling: Date/Time 4/13/16 09:31	
						Depth (ft bgs) 13.91	

SAMPLE		BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
NUMBER AND TYPE	RECOVERY (%)							
1 CS	80		5	CLAY mostly clay, few coarse gravel, high plasticity, dark gray (10YR 4/1) mottled with brown (10YR 5/3), very stiff. Change to no gravel at 1.0 feet. Change to stiff at 10.5 feet. Change to dark gray (10YR 4/1), very soft at 12.0 feet.	CL			Continuous sampling with 4-inch diameter casing from ground surface to terminus of soil boring, over-drilled with 6-inch diameter casing to install monitoring well.
2 CS	100		10					
3 CS	100		25					
4 CS	100		35					

SOIL BORING WELL CONSTRUCTION LOG 231828.0003.0000.GPJ TRC CORP.GDT 7/14/16

Signature:

Firm:	TRC Environmental Corporation	734.971.7080
	1540 Eisenhower Place Ann Arbor, Michigan	Fax 734.971.9022

Checked By: C. Scieszka



WELL CONSTRUCTION LOG

WELL NO. MW-16-04

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SAMPLE		BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
NUMBER AND TYPE	RECOVERY (%)							
5 CS	100		45	CLAY mostly clay, high plasticity, dark gray (10YR 4/1), very soft.				
6 CS	100		55		CL			
7 CS	100		65	Change to few coarse gravel at 60.0 feet.				
8 CS	100		75	SILTY CLAY mostly clay, little to some silt, trace fine sand, medium plasticity, dark gray (10YR 4/1), very stiff.	CL-ML			
			80	SILT mostly silt, trace to few fine sand, non plastic, dark gray (10YR 4/1), saturated, stiff.	ML			
			85	SAND mostly fine sand, few medium to coarse sand, dark gray (10YR 4/1), moist.	SP			
				SANDY CLAY mostly clay, some fine sand, high plasticity, dark gray (10YR 4/1), moist.	CL			
9 CS	100			SILTY CLAY mostly clay, some silt, high plasticity, dark gray (10YR 4/1), stiff.	CL-ML			
				CLAYEY SILT mostly silt, some clay, low plasticity, dark gray (10YR 4/1), stiff.	ML-CL			
			90	SILTY CLAY mostly clay, some silt, high plasticity, dark gray (10YR 4/1), stiff.				
10 CS	100		95		CL-ML			
			100	CLAY mostly clay, high plasticity, dark gray (10YR 4/1), very soft.	CL			







SOIL BORING WELL CONSTRUCTION LOG 231828 0003 0000.GPJ TRC CORP.GDT 7/14/16



WELL CONSTRUCTION LOG

WELL NO. MW-16-04

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SAMPLE		BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
NUMBER AND TYPE	RECOVERY (%)							
11 CS	100		105	CLAY mostly clay, high plasticity, dark gray (10YR 4/1), very soft.	CL			
12 CS	100		115	SILT mostly silt, few fine sand, nonplastic, dark gray (10YR 4/1), saturated, stiff.	ML			
13 CS	100		125	SAND mostly fine sand, dark gray (10YR 4/1), saturated.	SP			
			130	End of boring at 130.0 feet below ground surface.				
			135					
			140					
			145					
			150					
			155					



WELL CONSTRUCTION LOG

WELL NO. MW-16-05

Page 1 of 3

Facility/Project Name: DTE Electric Company Belle River Power Plant		Date Drilling Started: 3/3/16		Date Drilling Completed: 3/4/16		Project Number: 231828.0003					
Drilling Firm: Stock Drilling		Drilling Method: Sonic		Surface Elev. (ft) 588.32		TOC Elevation (ft) 590.82		Total Depth (ft bgs) 150.0		Borehole Dia. (in) 6	
Boring Location: S end of haul road, W of diversion basin. N: 470378.15 E: 13626342.79				Personnel Logged By - A. Knutson Driller - A. Goldsmith				Drilling Equipment: TSi 150cc			
Civil Town/City/or Village: China Township		County: St. Clair		State: MI		Water Level Observations: While Drilling: Date/Time After Drilling: Date/Time 4/13/16 09:55				Depth (ft bgs) 14.37	

SAMPLE		BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
NUMBER AND TYPE	RECOVERY (%)							
1 CS	80		5	CLAY WITH GRAVEL mostly clay, few to some coarse gravel, high plasticity, dark grayish brown (10YR 4/2), moist, very stiff. CLAY mostly clay, few fine to coarse gravel, high plasticity, dark gray (10YR 4/1) mottled with brown (10YR 5/3), moist, hard. Change to no gravel, very stiff at 4.0 feet.	CL			Continuous sampling with 4-inch diameter casing from ground surface to terminus of soil boring, over-drilled with 6-inch diameter casing to install monitoring well.
2 CS	100		10	Change to dark gray (10YR 4/1), very soft at 10.0 feet.				
3 CS	100		25	Change to medium stiff at 26.0 feet. Change to very soft at 28.0 feet.	CL			
4 CS	100		35					

SOIL BORING WELL CONSTRUCTION LOG 231828.0003.0000.GPJ TRC CORP.GDT 7/14/16

Signature:

Firm: TRC Environmental Corporation
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Checked By: C. Scieszka



WELL CONSTRUCTION LOG

WELL NO. MW-16-05

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SAMPLE		BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
NUMBER AND TYPE	RECOVERY (%)							
5 CS	100		45	CLAY mostly clay, high plasticity, dark gray (10YR 4/1), moist, very soft.	CL			
				SILTY CLAY mostly clay, little to some silt, medium plasticity, dark gray (10YR 4/1), very soft.	CL-ML			
6 ST	100		50	CLAY mostly clay, high plasticity, dark gray (10YR 4/1), moist, very soft.				
7 CS	100		55					
			60	Change to few fine to coarse gravel at 60.0 feet.	CL			
8 CS	100		65	Change to medium stiff at 65.0 feet.				
				Change to stiff at 67.5 feet.				
			70	SILTY CLAY mostly clay, some silt, few fine to coarse gravel, high plasticity, very dark gray (10YR 3/1), very stiff.				
9 CS	100		75					
				Change to low plasticity, black (10YR 2/1), hard at 77.0 feet.				
			80		CL-ML			
10 CS	60		85	Change to few to little fine sand at 85.5 feet.				
			90	CLAY mostly clay, few coarse gravel, high plasticity, dark gray (10YR 4/1), moist, very soft.				
11 CS	100		95	Change to medium stiff at 93.5 feet.				
				Change to soft at 97.5 feet.	CL			
			100					

SOIL BORING WELL CONSTRUCTION LOG 231828.0003.0000.GPJ TRC CORP.GDT 7/14/16



WELL CONSTRUCTION LOG

WELL NO. MW-16-05

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SAMPLE		BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
NUMBER AND TYPE	RECOVERY (%)							
12 CS	100		105	CLAY mostly clay, few coarse gravel, high plasticity, dark gray (10YR 4/1), moist, soft.	CL			
13 CS	100		110					
14 CS	100		115					
15 CS	100		120	CLAYEY SILT mostly silt, some clay, medium plasticity, dark gray (10YR 4/1), wet, medium stiff.	ML-CL			
16 CS	90		125					
			130	SHALE dark gray (10YR 4/1), dry.				
			135					
			140	End of boring at 150.0 feet below ground surface.				
			145					
			150					
			155					



WELL CONSTRUCTION LOG

WELL NO. MW-16-06

Page 1 of 3

Facility/Project Name: DTE Electric Company Belle River Power Plant		Date Drilling Started: 3/10/16	Date Drilling Completed: 3/11/16	Project Number: 231828.0003	
Drilling Firm: Stock Drilling	Drilling Method: Sonic	Surface Elev. (ft) 589.98	TOC Elevation (ft) 593.21	Total Depth (ft bgs) 140.0	Borehole Dia. (in) 6
Boring Location: 123 feet S of road connecting to haul road, E of diversion basin. N: 470439.03 E: 13626796.04		Personnel Logged By - A. Knutson Driller - A. Goldsmith		Drilling Equipment: TSi 150cc	
Civil Town/City/or Village: China Township	County: St. Clair	State: MI	Water Level Observations: While Drilling: Date/Time After Drilling: Date/Time 4/13/16 10:01 Depth (ft bgs) 14.45		

SAMPLE NUMBER AND TYPE	RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
1 CS	50		5	GRAVEL WITH SAND mostly gravel, some fine to coarse sand, brown (10YR 5/3), moist, dense. CLAY mostly clay, high plasticity, dark gray (10YR 4/1) mottled with brown (10YR 5/3), moist, very stiff.				Continuous sampling with 4-inch diameter casing from ground surface to terminus of soil boring, over-drilled with 6-inch diameter casing to install monitoring well.
2 CS	100		10	Change to few coarse gravel at 10.0 feet.				
3 CS	100		15	Change to dark gray (10YR 4/1), stiff at 12.0 feet. Change to very soft at 13.0 feet.				
4 CS	100		20		CL			

SOIL BORING WELL CONSTRUCTION LOG 231828.0003.0000.GPJ TRC CORP.GDT 7/14/16

Signature:	Firm: TRC Environmental Corporation 1540 Eisenhower Place Ann Arbor, Michigan	734.971.7080 Fax 734.971.9022
Checked By: C. Scieszka		



WELL CONSTRUCTION LOG

WELL NO. MW-16-06

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SOIL BORING WELL CONSTRUCTION LOG 231828.0003.0000.GPJ TRC CORP.GDT 7/14/16

SAMPLE		BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
NUMBER AND TYPE	RECOVERY (%)							
5 CS	100		45	CLAY mostly clay, few coarse gravel, high plasticity, dark gray (10YR 4/1), moist, very soft.				
			50					
6 CS	100		55		CL			
			60					
7 CS	100		65					
			70	SILTY CLAY mostly clay, some silt, medium plasticity, dark gray (10YR 4/1), moist, medium stiff.	CL-ML			
				SAND mostly fine sand, few coarse sand, dark gray (10YR 4/1), moist.	SP			
8 CS	100		75	SILTY CLAY mostly clay, some silt, medium plasticity, dark gray (10YR 4/1), moist, medium stiff.				
			80		CL-ML			
9 CS	80		85					
			90	CLAY mostly clay, high plasticity, dark gray (10YR 4/1), moist, very soft.				
10 CS	70		95		CL			
			100					



WELL CONSTRUCTION LOG

WELL NO. MW-16-06

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SAMPLE		BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
NUMBER AND TYPE	RECOVERY (%)							
11 CS	100		105	CLAY mostly clay, high plasticity, dark gray (10YR 4/1), moist, very soft.	CL			
12 CS	100		110					
			115					
13 CS	100		120	SILTY CLAY mostly clay, some silt, medium plasticity, dark gray (10YR 4/1), moist, medium stiff.	CL-ML			
			125					
14 CS	100		130	SILT mostly silt, dark gray (10YR 4/1), saturated, very soft.	ML			
			135					
			140	SHALE dark gray (10YR 4/1), hard, brittle.				
			140	End of boring at 140.0 feet below ground surface.				
			145					
			150					
			155					



WELL CONSTRUCTION LOG

WELL NO. MW-16-07

Page 1 of 3

Facility/Project Name: DTE Electric Company Belle River Power Plant		Date Drilling Started: 3/8/16		Date Drilling Completed: 3/9/16		Project Number: 231828.0003					
Drilling Firm: Stock Drilling		Drilling Method: Sonic		Surface Elev. (ft) 589.89		TOC Elevation (ft) 592.58		Total Depth (ft bgs) 140.0		Borehole Dia. (in) 6	
Boring Location: 326 feet S of road connecting to haul road, E of diversion basin. N: 470233.47 E: 13626858.79				Personnel Logged By - A. Knutson Driller - A. Goldsmith				Drilling Equipment: TSi 150cc			
Civil Town/City/or Village: China Township		County: St. Clair		State: MI		Water Level Observations: While Drilling: Date/Time After Drilling: Date/Time 4/13/16 11:56				Depth (ft bgs) 14.13	

SAMPLE		BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
NUMBER AND TYPE	RECOVERY (%)							
1 CS	60		5	CLAY mostly clay, few coarse gravel, high plasticity, brown (10YR 5/3) mottled with dark gray (10YR 4/1), very stiff.				Continuous sampling with 4-inch diameter casing from ground surface to terminus of soil boring, over-drilled with 6-inch diameter casing to install monitoring well.
			10	Change to dark gray (10YR 4/1) mottled with brown (10YR 5/3) at 5.0 feet.				
			15	Change to dark gray (10YR 4/1) at 11.0 feet.				
2 CS	100		15	▼ Change to moist, very soft at 13.0 feet.				
			20					
3 CS	100		25					
			30					
4 CS	100		35					
			40					

SOIL BORING WELL CONSTRUCTION LOG 231828.0003.GPJ TRC CORP.GDT 7/14/16

Signature:

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Checked By:

C. Scieszka



WELL CONSTRUCTION LOG

WELL NO. MW-16-07

Page 2 of 3

SAMPLE		BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
NUMBER AND TYPE	RECOVERY (%)							
5 CS	100		45	CLAY mostly clay, few coarse gravel, high plasticity, dark gray (10YR 4/1), moist, very soft.	CL			
6 ST	100		50					
7 CS	100		55	SILTY CLAY mostly clay, little silt, high plasticity, dark gray (10YR 4/1), moist, soft.	CL- ML			
			60					
8 CS	100		65	CLAYEY SILT mostly silt, little to some clay, few fine to coarse sand, low plasticity, dark gray (10YR 4/1), moist.	ML- CL			
			65	SAND mostly fine to coarse sand, dark gray (10YR 4/1), moist, loose.	SW			
			65	CLAYEY SILT mostly silt, little to some clay, few fine to coarse sand, low plasticity, dark gray (10YR 4/1), moist.	ML- CL			
			70	SILTY CLAY mostly clay, little silt, high plasticity, dark gray (10YR 4/1), moist, soft.				
				Change to few coarse gravel at 70.0 feet.				
9 CS	100		75		CL- ML			
			80					
10 CS	100		85					
			90					
11 CS	100		95					
			100					

SOIL BORING WELL CONSTRUCTION LOG 231828.0003.0000.GPJ TRC CORP.GDT 7/14/16



WELL CONSTRUCTION LOG

WELL NO. MW-16-07

Page 3 of 3

SAMPLE		BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
NUMBER AND TYPE	RECOVERY (%)							
12 CS	100		105	SILTY CLAY mostly clay, little silt, high plasticity, dark gray (10YR 4/1), moist, soft.	CL-ML			
13 CS	80		110					
14 CS	100		125					
15 CS	100		130					
			135	SILT mostly silt, no plasticity, dark gray (10YR 4/1), saturated, loose.	ML			
			135	SHALE dark gray (10YR 4/1), brittle, hard.				
			140	End of boring at 140.0 feet below ground surface.				
			145					
			150					
			155					

SOIL BORING WELL CONSTRUCTION LOG 231828.0003.0000.GPJ TRC CORP.GDT 7/14/16



WELL CONSTRUCTION LOG

WELL NO. MW-16-08

Page 1 of 3

Facility/Project Name: DTE Electric Company Belle River Power Plant		Date Drilling Started: 3/9/16	Date Drilling Completed: 3/10/16	Project Number: 231828.0003	
Drilling Firm: Stock Drilling	Drilling Method: Sonic	Surface Elev. (ft) 589.31	TOC Elevation (ft) 591.88	Total Depth (ft bgs) 140.0	Borehole Dia. (in) 6
Boring Location: 566.6 feet S of road connecting to haul road, E of diversion basin. N: 470002.90 E: 13626846.85		Personnel Logged By - A. Knutson Driller - A. Goldsmith		Drilling Equipment: TSi 150cc	
Civil Town/City/or Village: China Township	County: St. Clair	State: MI	Water Level Observations: While Drilling: Date/Time After Drilling: Date/Time 4/13/16 12:00 Depth (ft bgs) 13.19		

SAMPLE NUMBER AND TYPE	RECOVERY (%)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
1 CS	50		5	CLAY WITH GRAVEL mostly clay, little coarse gravel, high plasticity, dark gray (10YR 4/1) mottled with brown (10YR 5/3), moist, very stiff.	CL			Continuous sampling with 4-inch diameter casing from ground surface to terminus of soil boring, over-drilled with 6-inch diameter casing to install monitoring well.
			10	CLAY mostly clay, high plasticity, dark gray (10YR 4/1) mottled with brown (10YR 5/3), moist, very stiff.				
			15	Change to dark gray (10YR 4/1), very soft at 10.0 feet.				
2 CS	100		20					
3 CS	100		25		CL			
4 CS	100		30					
			35					
			40					

SOIL BORING WELL CONSTRUCTION LOG 231828.0003.0000.GPJ TRC CORP.GDT 7/14/16

Signature:	Firm: TRC Environmental Corporation 1540 Eisenhower Place Ann Arbor, Michigan	734.971.7080 Fax 734.971.9022
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Checked By: C. Scieszka



WELL CONSTRUCTION LOG

WELL NO. MW-16-08

Page 2 of 3

SAMPLE		BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
NUMBER AND TYPE	RECOVERY (%)							
5 CS	100		45	CLAY mostly clay, high plasticity, dark gray (10YR 4/1), moist, very soft.	CL			
6 CS	100		50					
7 CS	80		55					
8 CS	100		60	SILTY CLAY mostly clay, some silt, few coarse gravel, high plasticity, dark gray (10YR 4/1), moist, soft.	CL-ML			
9 CS	100		65					
10 CS	60		70					
			75					
			80					
			85					
			90					
			95					
			100					

SOIL BORING WELL CONSTRUCTION LOG 231828.0003.0000.GPJ TRC CORP.GDT 7/14/16



WELL CONSTRUCTION LOG

WELL NO. MW-16-08

Page 3 of 3

SAMPLE		BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
NUMBER AND TYPE	RECOVERY (%)							
11 CS	100		105	SILTY CLAY mostly clay, some silt, few coarse gravel, high plasticity, dark gray (10YR 4/1), moist, soft.				
				Change to few fine sand at 105.5 feet.				
			110	Change to no sand at 110.0 feet.				
12 CS	100		115		CL-ML			
			120					
13 CS	100		125					
			130	SILT mostly silt, dark gray (10YR 4/1), saturated, very soft.	ML			
14 CS	100		135	SHALE dark gray (10YR 4/1), brittle, hard.				
			140	End of boring at 140.0 feet below ground surface.				
			145					
			150					
			155					



WELL CONSTRUCTION LOG

WELL NO. MW-16-09

Page 1 of 3

Facility/Project Name: DTE Electric Company Belle River Power Plant		Date Drilling Started: 6/1/16		Date Drilling Completed: 6/1/16		Project Number: 231828.0003					
Drilling Firm: Stock Drilling		Drilling Method: Sonic		Surface Elev. (ft) 588.28		TOC Elevation (ft) 590.80		Total Depth (ft bgs) 150.0		Borehole Dia. (in) 6	
Boring Location: E of bottom ash basins, E of haul road. N: 471284.45 E: 13626365.84				Personnel Logged By - J. Reed Driller - A. Goldsmith				Drilling Equipment: TSi 150cc			
Civil Town/City/or Village: China Township		County: St. Clair		State: MI		Water Level Observations: While Drilling: Date/Time After Drilling: Date/Time 6/9/16 15:13				Depth (ft bgs) 14.36	

SAMPLE		BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
NUMBER AND TYPE	RECOVERY (%)							
1 CS	75		5	TOPSOIL SILTY CLAY mostly clay, little to some silt, few fine to coarse sand, trace to few fine gravel, low plasticity, dark grayish brown (10YR 4/2), moist, stiff.	CL-ML			Continuous sampling with 4-inch diameter casing from ground surface to terminus of soil boring, over-drilled with 6-inch diameter casing to install monitoring well.
2 CS	85		15	CLAY mostly clay, few silt, trace to few fine to coarse sand, medium plasticity, gray (10YR 5/1), moist, soft.				
3 CS	100		25		CL			
4 CS	100		35	Change to trace to few fine gravel at 30.0 feet.				

SOIL BORING WELL CONSTRUCTION LOG 231828.0003.0000.GPJ TRC CORP.GDT 7/14/16

Signature:	Firm: TRC Environmental Corporation 1540 Eisenhower Place Ann Arbor, Michigan	734.971.7080 Fax 734.971.9022
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Checked By: M. Powers



WELL CONSTRUCTION LOG

WELL NO. MW-16-09

Page 2 of 3

SAMPLE		BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
NUMBER AND TYPE	RECOVERY (%)							
5 CS	100		45	CLAY mostly clay, few silt, trace to few fine to coarse sand, trace to few fine gravel, medium plasticity, gray (10YR 5/1), moist, soft.				
			50	Change to soft to medium stiff at 50.0 feet.				
			55					
			60					
			65					
6 CS	100		70	Change to soft at 70.0 feet.				
			75		CL			
			80	Change to medium stiff to stiff at 80.0 feet.				
			85	Change to stiff at 85.0 feet.				
			90					
			95					
			100					



WELL CONSTRUCTION LOG

WELL NO. MW-16-09

Page 3 of 3

SAMPLE		BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
NUMBER AND TYPE	RECOVERY (%)							
8 CS	75		105	CLAY mostly clay, few silt, trace to few fine to coarse sand, trace to few fine gravel, medium plasticity, gray (10YR 5/1), moist, stiff. Change to medium stiff at 105.0 feet.				
9 CS	80		110					
			115					
			120		CL			
			125					
10 CS	100		130					
			135					
			140	SAND mostly fine sand, trace silt, dark gray (10YR 4/1), moist, loose.	SP			
11 CS	80		145	SAND WITH GRAVEL mostly fine to coarse sand, little to some fine to medium gravel, trace to few silt, trace to few clay, dark gray (10YR 4/1), moist to wet, loose.	SW			
			150	SHALE weathered, gray (10YR 5/1), brittle.				
			155	End of boring at 150.0 feet below ground surface.				



WELL CONSTRUCTION LOG

WELL NO. MW-16-10

Page 1 of 3

Facility/Project Name: DTE Electric Company Belle River Power Plant		Date Drilling Started: 6/2/16	Date Drilling Completed: 6/3/16	Project Number: 231828.0003	
Drilling Firm: Stock Drilling	Drilling Method: Sonic	Surface Elev. (ft) 589.25	TOC Elevation (ft) 592.26	Total Depth (ft bgs) 150.0	Borehole Dia. (in) 6
Boring Location: S end of haul road, W/NW of diversion basin. N: 470532.54 E: 13626417.00		Personnel Logged By - J. Reed Driller - A. Goldsmith		Drilling Equipment: TSi 150cc	
Civil Town/City/or Village: China Township	County: St. Clair	State: MI	Water Level Observations: While Drilling: Date/Time After Drilling: Date/Time 6/9/16 07:45 Depth (ft bgs) 15.30		

SAMPLE		BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
NUMBER AND TYPE	RECOVERY (%)							
1 CS	50		5	TOPSOIL CLAY mostly clay, few silt, trace to few fine to coarse sand, dark grayish brown (10YR 4/2), moist, medium stiff to stiff.				Continuous sampling with 4-inch diameter casing from ground surface to terminus of soil boring, over-drilled with 6-inch diameter casing to install monitoring well.
2 CS	90		15	Change to gray (10YR 5/1) at 11.0 feet. Change to soft to medium stiff at 12.0 feet.				
3 CS	95		25	Change to soft at 25.0 feet.				
4 CS	100		35	Change to few fine to coarse sand, medium stiff at 30.0 feet. Change to dark gray (10YR 4/1) at 32.0 feet. Change to soft at 35.0 feet.	CL			

SOIL BORING WELL CONSTRUCTION LOG 231828.0003.0000.GPJ TRC CORP.GDT 7/14/16

Signature:	Firm: TRC Environmental Corporation 1540 Eisenhower Place Ann Arbor, Michigan	734.971.7080 Fax 734.971.9022
Checked By: <u>M. Powers</u>		



WELL CONSTRUCTION LOG

WELL NO. MW-16-10

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SAMPLE		BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
NUMBER AND TYPE	RECOVERY (%)							
5 CS	100		45	CLAY mostly clay, few silt, trace to few fine to coarse sand, dark gray (10YR 4/1), moist, soft.				
			50					
6 CS	100		55		CL			
			60					
7 CS	100		65					
			70	CLAY WITH SAND mostly clay, little fine to coarse sand, few silt, trace gravel, dark gray (10YR 4/1), moist, very stiff.				
8 CS	100		75	Change to few to little medium to coarse sand, low to medium plasticity, stiff at 75.0 feet.	CL			
			80	CLAYEY SAND mostly fine to coarse sand, some clay, dark grayish brown (10YR 4/2), moist, medium dense.	SC			
9 CS	100		85	SAND mostly fine to medium sand, dark grayish brown (10YR 4/2), moist, loose.	SP			
			90	SANDY CLAY mostly clay, little to some fine to coarse sand, few silt, medium plasticity, dark grayish brown (10YR 4/2), moist, medium stiff to stiff.				
10 CS	100		95		CL			
			100	CLAY WITH SAND mostly clay, little fine to coarse sand, few silt, medium plasticity, dark grayish brown (10YR 4/2), moist, medium stiff to stiff.	CL			

SOIL BORING WELL CONSTRUCTION LOG 231828.0003.0000.GPJ TRC CORP.GDT 7/14/16



WELL CONSTRUCTION LOG

WELL NO. MW-16-10

Page 3 of 3

SAMPLE		BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
NUMBER AND TYPE	RECOVERY (%)							
11 CS	100		105	CLAY WITH SAND mostly clay, little fine to coarse sand, few silt, medium plasticity, dark grayish brown (10YR 4/2), moist, medium stiff to stiff.	CL			
			110	SANDY CLAY mostly clay, little to some fine to coarse sand, few silt, medium plasticity, dark grayish brown (10YR 4/2), moist, medium stiff.	CL			
12 CS	100		115	SAND mostly medium to coarse sand, dark gray (10YR 4/1), moist, loose.	SP			
			120	CLAY mostly clay, little sand, few to little silt, dark gray (10YR 4/1), moist, stiff.				
13 CS	95		125					
			130		CL			
14 CS	95		135					
			140					
15 CS	50		145	GRAVELLY SILT mostly silt, some fine to coarse gravel, few clay, few sand, low to medium plasticity, dark gray (10YR 4/1), moist, soft.	ML			
			150	SILTY CLAY hard, dark gray (10YR 4/1), hardpan, brittle.	CL-ML			
			150	SHALE dark gray.				
				End of boring at 150.0 feet below ground surface.				
			155					
			160					



WELL CONSTRUCTION LOG

WELL NO. MW-16-11

Page 1 of 3

Facility/Project Name: DTE Electric Company Belle River Power Plant		Date Drilling Started: 6/3/16		Date Drilling Completed: 6/6/16		Project Number: 231828.0003					
Drilling Firm: Stock Drilling		Drilling Method: Sonic		Surface Elev. (ft) 589.03		TOC Elevation (ft) 591.54		Total Depth (ft bgs) 150.0		Borehole Dia. (in) 6	
Boring Location: S of haul road, W of diversion basin. N: 470251.34 E: 13626438.92				Personnel Logged By - J. Reed Driller - A. Goldsmith				Drilling Equipment: TSi 150cc			
Civil Town/City/or Village: China Township		County: St. Clair		State: MI		Water Level Observations: While Drilling: Date/Time After Drilling: Date/Time 6/21/16 07:45				Depth (ft bgs) 14.47	

SAMPLE		BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
NUMBER AND TYPE	RECOVERY (%)							
1 CS	50		5	TOPSOIL CLAY mostly clay, few silt, trace to few sand, few gravel, low to medium plasticity, dark grayish brown (10YR 4/2), moist, stiff.				Continuous sampling with 4-inch diameter casing from ground surface to terminus of soil boring, over-drilled with 6-inch diameter casing to install monitoring well.
			10	Change to trace gravel at 8.0 feet.				
2 CS	70		15	Change to gray (10YR 5/1) at 12.0 feet. Change to no gravel at 13.0 feet.				
			20	Change to medium stiff at 21.0 feet.	CL			
3 CS	90		25					
			30					
4 CS	90		35	Change to soft to medium stiff at 34.5 feet.				
			40					

SOIL BORING WELL CONSTRUCTION LOG 231828.0003.GPJ TRC CORP.GDT 7/14/16

Signature:

Firm:

TRC Environmental Corporation
1540 Eisenhower Place Ann Arbor, Michigan

734.971.7080

Fax 734.971.9022

Checked By:


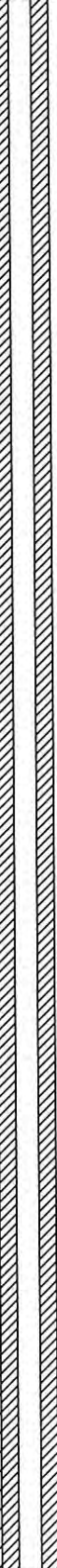
M. Powers



WELL CONSTRUCTION LOG

WELL NO. MW-16-11

Page 2 of 3

SAMPLE		BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
NUMBER AND TYPE	RECOVERY (%)							
5 CS	90		45	CLAY mostly clay, few silt, trace to few sand, medium plasticity, gray (10YR 5/1), moist, soft to medium stiff.	CL			
			50	Change to medium stiff at 49.0 feet.				
6 CS	100		55					
			60	Change to soft at 60.0 feet.				
7 CS	100		65					
			70	Change to trace gravel, soft to medium stiff at 70.0 feet.				
8 CS	100		75	Change to medium stiff at 75.0 feet.				
			80					
9 CS	90		85					
			90					
10 CS	90		95	Change to medium stiff to stiff at 95.0 feet.				
			100					

SOIL BORING WELL CONSTRUCTION LOG 231828.0003.0000.GPJ TRC CORP.GDT 7/14/16



WELL CONSTRUCTION LOG

WELL NO. MW-16-11

Page 3 of 3

SAMPLE		BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
NUMBER AND TYPE	RECOVERY (%)							
11 CS	85		105	CLAY mostly clay, few silt, trace to few sand, trace gravel, low to medium plasticity, gray (10YR 5/1), moist, medium stiff to stiff.				
			110	Change to medium stiff at 110.0 feet.				
12 CS	80		115					
			120		CL			
13 CS	85		125					
			130					
14 CS	90		135					
			140	SANDY CLAY mostly clay, some fine sand, few silt, dark gray (10YR 4/1), moist.	CL			
				CLAY mostly clay, few silt, trace to few sand, trace gravel, low to medium plasticity, gray (10YR 5/1), moist, medium stiff.	CL			
				SHALE dark gray.				
15 CS	90		145					
			150	End of boring 150.0 feet below ground surface.				
			155					

SOIL BORING WELL CONSTRUCTION LOG 231828.0003.0000.GPJ TRC CORP.GDT 7/14/16



WELL CONSTRUCTION LOG

WELL NO. MW-16-11A

Page 1 of 2

Facility/Project Name: DTE Electric Company Belle River Power Plant		Date Drilling Started: 5/11/17	Date Drilling Completed: 5/12/17	Project Number: 231828.0003	
Drilling Firm: Stock Drilling	Drilling Method: Sonic	Surface Elev. (ft) 589.5	TOC Elevation (ft) 591.66	Total Depth (ft bgs) 142.0	Borehole Dia. (in) 6
Boring Location: North of fuel oil tank number 2, between berm and fence.		Personnel Logged By - J. Krenz Driller - A. Goldsmith		Drilling Equipment: TSi 150cc	
Civil Town/City/or Village: China Township	County: St. Clair	State: MI	Water Level Observations: While Drilling: Date/Time After Drilling: Date/Time 5/15/17 08:38 Depth (ft bgs) 17.79		

SAMPLE		BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
NUMBER AND TYPE	RECOVERY (%)							
1 CS	90			CLAY mostly clay, trace gravel, medium plasticity, dark grayish brown (10YR 4/2), mottled with dark yellowish brown (10YR 4/6), medium stiff, moist, plant roots to 0.5 feet. ▼ Change to high plasticity, gray (10YR 5/1), soft at 19.0 feet.	CL			Continuous sampling with 4-inch diameter casing from ground surface to terminus of soil boring, over-drilled with 6-inch diameter casing to install monitoring well.
2 CS	60		10					
3 CS	70		20					
4 CS	70		30					
5 CS	100		40					
6 CS	100		50					
7			60					

Signature:	Firm: TRC Environmental	Fax
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Checked By: C. Scieszka

SOIL BORING WELL CONSTRUCTION LOG 231828.0003.GPJ TRC CORP GDT 8/21/17



WELL CONSTRUCTION LOG

WELL NO. MW-16-11A

Page 2 of 2

SOIL BORING WELL CONSTRUCTION LOG 231828.0003.0000.GPJ TRC CORP GDT 8/21/17

SAMPLE		BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	WELL DIAGRAM	COMMENTS
NUMBER AND TYPE	RECOVERY (%)							
CS	100			CLAY mostly clay, trace fine to medium gravel, high plasticity, gray (10YR 5/1), medium stiff, moist.				
			70	Change to few fine to coarse gravel at 70.0 feet.				
8 CS	100							
			80	Change to trace fine sand at 80.0 feet.				
9 CS	90							
			90					
10 CS	70							
			100		CL			
11 CS	100							
			110					
12 CS	100							
			120					
13 CS	100			Change to trace medium to coarse gravel at 126.0 feet.				
			130					
14 CS	60			SILT mostly silt, trace clay, dark gray (10YR 4/1), dense, saturated.	ML			
			140	SILTY CLAY mostly clay, some silt, few to little fine to coarse gravel, medium to low plasticity, dark gray (10YR 4/1), moist, medium stiff, inclusions of shale bedrock.	CL-ML			
15 CS	100			BEDROCK shale, weathered, gray (10YR 4/1). End of boring at 142.0 feet below ground surface.				
			150					




SOIL BORING LOG

BORING NO. SB-16-01

Page 1 of 3

Facility/Project Name: DTE Electric Company Belle River Power Plant		Date Drilling Started: 3/1/16		Date Drilling Completed: 3/1/16		Project Number: 231828.0003					
Drilling Firm: Stock Drilling		Drilling Method: Sonic		Surface Elev. (ft) 588.69		TOC Elevation (ft) ---		Total Depth (ft bgs) 150.0		Borehole Dia. (in) 6	
Boring Location: Corner of E connecting road off haul road, E of bottom ash basins. N: 471096.38 E: 13626276.67				Personnel Logged By - A. Knutson Driller - A. Goldsmith				Drilling Equipment: TSi 150cc			
Civil Town/City/or Village: China Township		County: St. Clair		State: MI		Water Level Observations: While Drilling: Date/Time After Drilling: Date/Time				Depth (ft bgs) Depth (ft bgs)	

SAMPLE		BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	COMMENTS
NUMBER AND TYPE	RECOVERY (%)						
1 CS	50		5	CLAY WITH GRAVEL mostly clay, little fine to coarse gravel, few fine sand, high plasticity, dark gray (10YR 4/1), mottled with brown (10YR 5/3), moist, very stiff. CLAY mostly clay, trace fine sand, high plasticity, dark gray (10YR 4/1), mottled with brown (10YR 5/3), moist, very stiff.	CL		Continuous sampling with 4-inch diameter casing from ground surface to terminus of soil boring, over-drilled with 6-inch diameter casing to total depth.
			10	Change to stiff at 10.0 feet.			
2 CS	100		15	Change to no sand, dark gray (10YR 4/1), very soft at 13.0 feet.			
			20				
3 CS	100		25				Continuous sampling with 4-inch diameter casing from ground surface to terminus of soil boring, over-drilled with 6-inch diameter casing to total depth.
			30				
4 CS	100		35				
			40				

SOIL BORING WELL CONSTRUCTION LOG 231828.0003.0000.GPJ TRC CORP.GDT 7/14/16

Signature:

Checked By:

M. Powers

Firm:

TRC Environmental Corporation
1540 Eisenhower Place Ann Arbor, Michigan

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SOIL BORING LOG

BORING NO. SB-16-01

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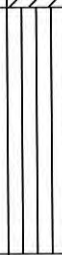

SAMPLE		BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	COMMENTS
NUMBER AND TYPE	RECOVERY (%)						
5 CS	100		45	CLAY mostly clay, high plasticity, dark gray (10YR 4/1), moist, very soft.			
6 ST	100		50		CL		
7 CS	100		55		CL		
			60	CLAY WITH SAND mostly clay, little fine to coarse sand, high plasticity, dark gray (10YR 4/1), moist, very soft. CLAY mostly clay, high plasticity, dark gray (10YR 4/1), moist, very soft.	CL		
8 CS	100		65	SANDY SILT mostly silt, little to some fine to coarse sand, few clay, low plasticity, dark gray (10YR 4/1), moist, stiff.	ML		
9 CS	100		70	CLAY mostly clay, few fine to coarse gravel, dark gray (10YR 4/1), moist, medium stiff. Change to no gravel, soft at 72.5 feet.			
			75				
			80	Change to few coarse gravel at 80.0 feet.			
10 CS	100		85		CL		
			90				
11 CS	100		95				
			100				



SOIL BORING LOG

BORING NO. SB-16-01

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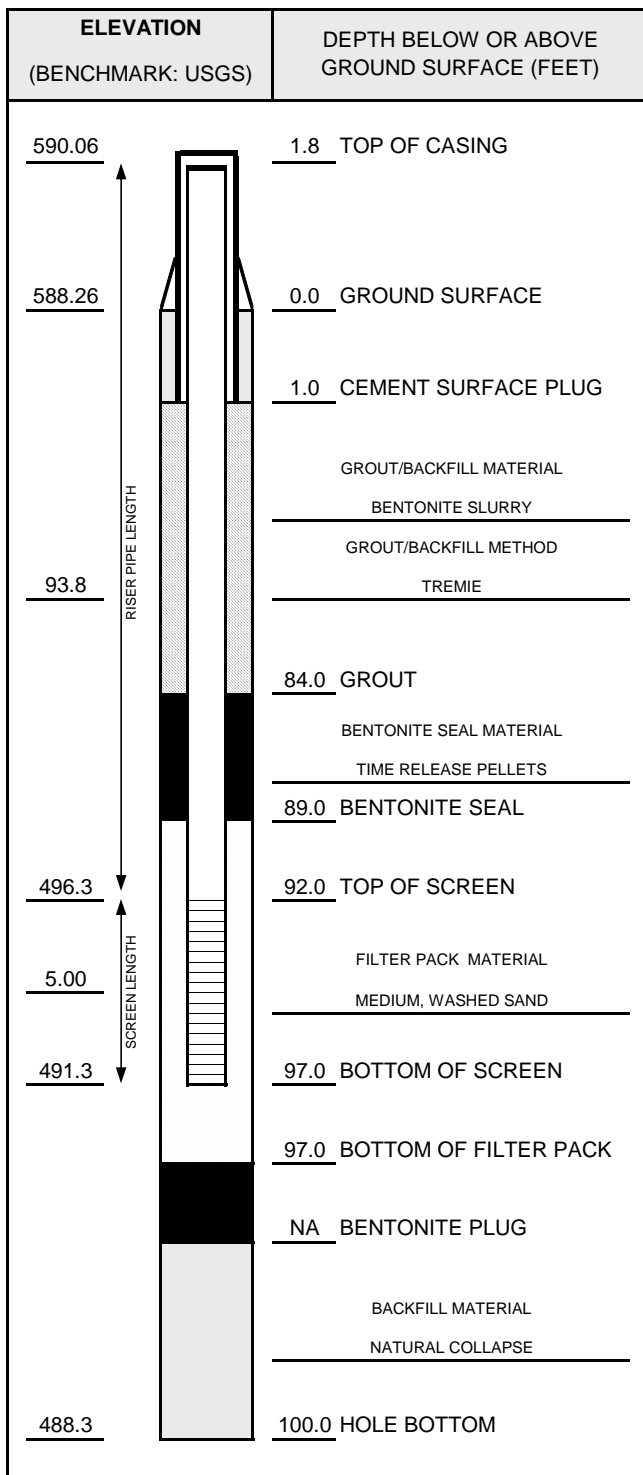
SAMPLE		BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	GRAPHIC LOG	COMMENTS
NUMBER AND TYPE	RECOVERY (%)						
12 CS	100		105	CLAY mostly clay, few coarse gravel, dark gray (10YR 4/1), moist, soft.	CL		
			110				
13 CS	100		115				
			120				
14 CS	100		125	SILT mostly silt, few fine sand, non plastic, dark gray (10YR 4/1), moist.	ML		
			130				
15 CS	100		135				
			140				
16 CS	100		145	SHALE dark gray (10YR 4/1), dry.			
			150	End of boring at 150.0 feet below ground surface.			
			155				

SOIL BORING WELL CONSTRUCTION LOG 231828.0003.0000.GPJ TRC CORP.GDT 7/14/16



WELL CONSTRUCTION DIAGRAM

PROJ. NAME: DTE Electric Company Belle River Power Plant		WELL ID: MW-16-01
PROJ. NO: 231828.0003	DATE INSTALLED: 3/17/2016	INSTALLED BY: A. Knutson
		CHECKED BY: C. Scieszka



NOTES:

CASING AND SCREEN DETAILS	
TYPE OF RISER:	2-INCH PVC
PIPE SCHEDULE:	40
PIPE JOINTS:	THREADED O-RINGS
SCREEN TYPE:	2-INCH PVC
SCR. SLOT SIZE:	0.01-INCH
BOREHOLE DIAMETER:	6 IN. FROM 0 TO 97 FT. 4 IN. FROM 97 TO 100 FT.
SURF. CASING DIAMETER:	IN. FROM TO FT. IN. FROM TO FT.

WELL DEVELOPMENT	
DEVELOPMENT METHOD:	AIR LIFT
TIME DEVELOPING:	4 HOURS
WATER REMOVED:	120 GALLONS
WATER ADDED:	0 GALLONS
WATER CLARITY BEFORE / AFTER DEVELOPMENT	
CLARITY BEFORE:	VERY TURBID
COLOR BEFORE:	BROWN /GREY
CLARITY AFTER:	CLEAR
COLOR AFTER:	NONE
ODOR (IF PRESENT):	NONE

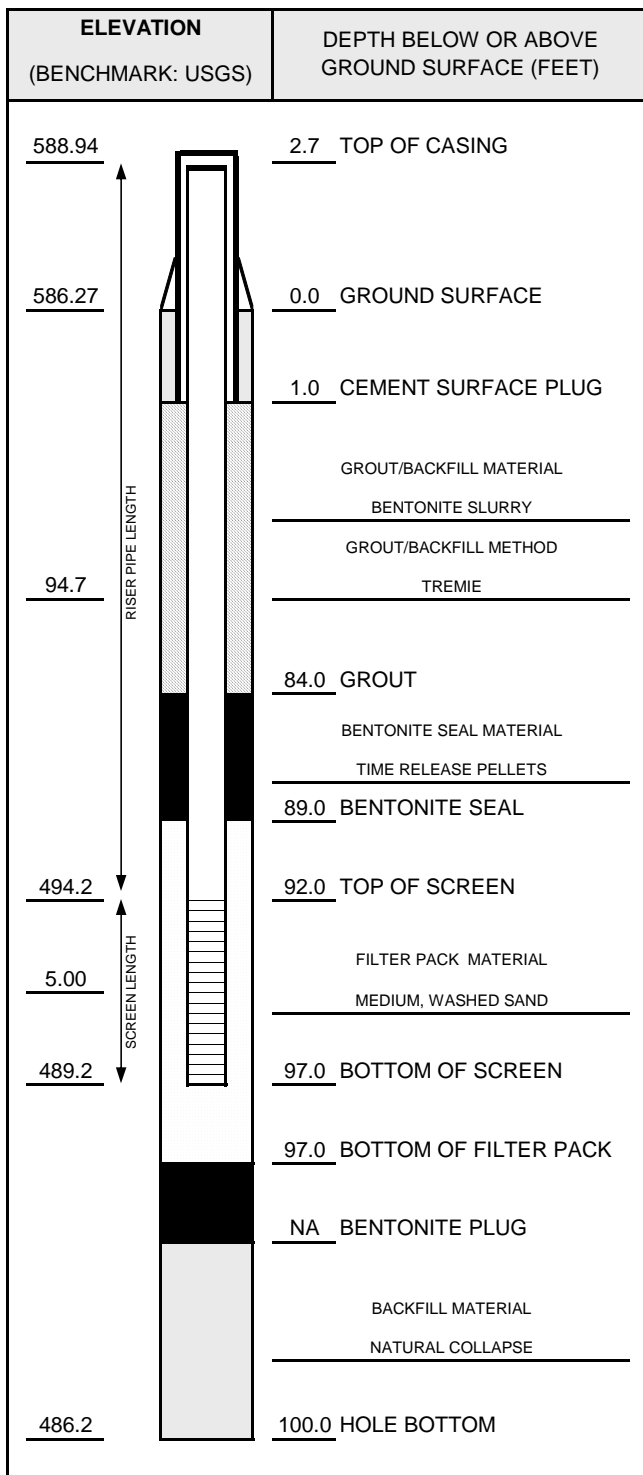
WATER LEVEL SUMMARY				
MEASUREMENT (FEET)			DATE	TIME
DTB BEFORE DEVELOPING:	98.20	T/PVC	3/21/2016	--
DTB AFTER DEVELOPING:	100.32	T/PVC	4/13/2016	845
SWL BEFORE DEVELOPING:	12.92	T/PVC	3/21/2016	--
SWL AFTER DEVELOPING:	16.32	T/PVC	4/13/2016	845
OTHER SWL:		T/PVC		
OTHER SWL:		T/PVC		

PROTECTIVE CASING DETAILS	
PERMANENT, LEGIBLE WELL LABEL ADDED?	<input checked="" type="checkbox"/> YES <input type="checkbox"/> NO
PROTECTIVE COVER AND LOCK INSTALLED?	<input checked="" type="checkbox"/> YES <input type="checkbox"/> NO
LOCK KEY NUMBER:	3120



WELL CONSTRUCTION DIAGRAM

PROJ. NAME: DTE Electric Company Belle River Power Plant				WELL ID:	MW-16-02
PROJ. NO:	231828.0003	DATE INSTALLED: 3/15/2016 INSTALLED BY: A. Knutson			CHECKED BY: C. Scieszka



NOTES:

CASING AND SCREEN DETAILS	
TYPE OF RISER:	2-INCH PVC
PIPE SCHEDULE:	40
PIPE JOINTS:	THREADED O-RINGS
SCREEN TYPE:	2-INCH PVC
SCR. SLOT SIZE:	0.01-INCH
BOREHOLE DIAMETER:	6 IN. FROM 0 TO 97 FT. 4 IN. FROM 97 TO 100 FT.
SURF. CASING DIAMETER:	IN. FROM TO FT. IN. FROM TO FT.

WELL DEVELOPMENT	
DEVELOPMENT METHOD:	AIR LIFT
TIME DEVELOPING:	4 HOURS
WATER REMOVED:	460 GALLONS
WATER ADDED:	0 GALLONS
WATER CLARITY BEFORE / AFTER DEVELOPMENT	
CLARITY BEFORE:	VERY TURBID
COLOR BEFORE:	BROWN /GREY
CLARITY AFTER:	CLEAR
COLOR AFTER:	NONE
ODOR (IF PRESENT):	NONE

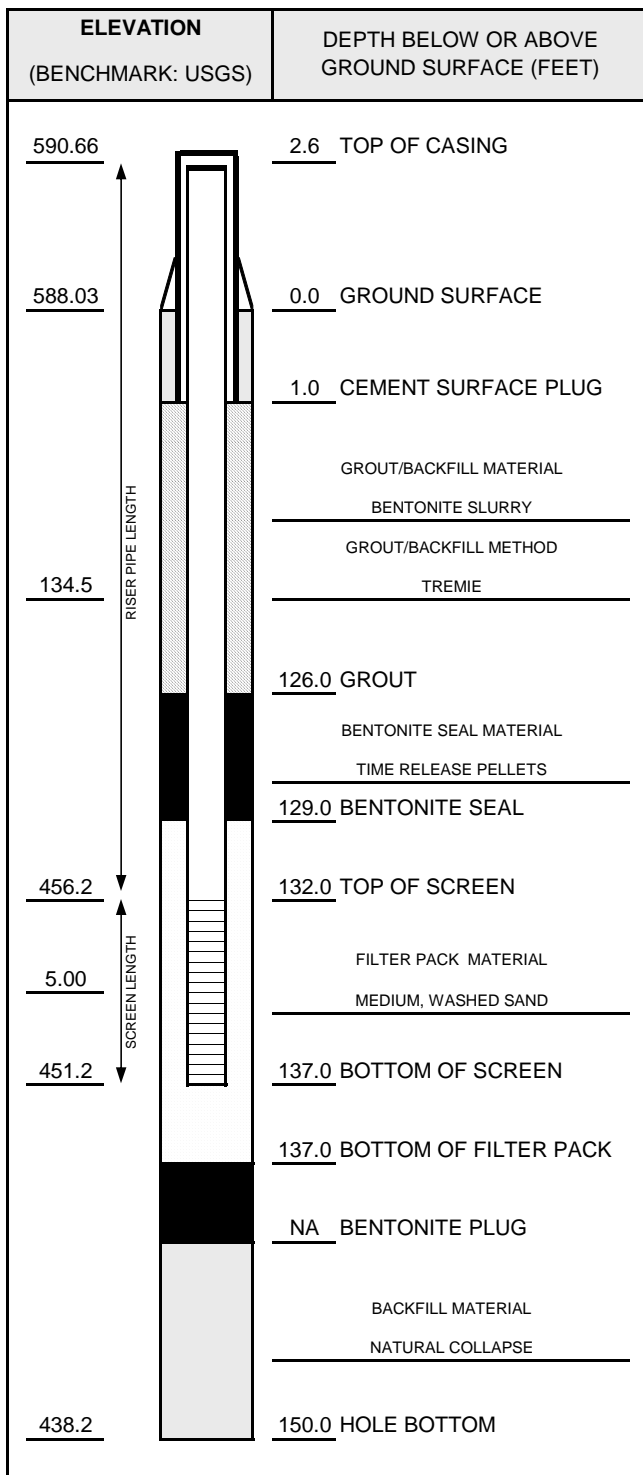
WATER LEVEL SUMMARY			DATE	TIME
MEASUREMENT (FEET)				
DTB BEFORE DEVELOPING:	97.07	T/PVC	3/15/2016	--
DTB AFTER DEVELOPING:	100.20	T/PVC	4/13/2016	9:24
SWL BEFORE DEVELOPING:	14.56	T/PVC	3/15/2016	--
SWL AFTER DEVELOPING:	28.28	T/PVC	3/18/2016	--
OTHER SWL:	18.77	T/PVC	4/13/2016	9:24
OTHER SWL:		T/PVC		

PROTECTIVE CASING DETAILS	
PERMANENT, LEGIBLE WELL LABEL ADDED?	<input checked="" type="checkbox"/> YES <input type="checkbox"/> NO
PROTECTIVE COVER AND LOCK INSTALLED?	<input checked="" type="checkbox"/> YES <input type="checkbox"/> NO
LOCK KEY NUMBER:	3120



WELL CONSTRUCTION DIAGRAM

PROJ. NAME: DTE Electric Company Belle River Power Plant		WELL ID: MW-16-03
PROJ. NO: 231828.0003	DATE INSTALLED: 6/1/2016	INSTALLED BY: J. Reed
		CHECKED BY: M. Powers



NOTES:

CASING AND SCREEN DETAILS	
TYPE OF RISER:	2-INCH PVC
PIPE SCHEDULE:	40
PIPE JOINTS:	THREADED O-RINGS
SCREEN TYPE:	2-INCH PVC
SCR. SLOT SIZE:	0.01-INCH
BOREHOLE DIAMETER:	6 IN. FROM 0 TO 140 FT. 4 IN. FROM 140 TO 150 FT.
SURF. CASING DIAMETER:	IN. FROM TO FT. IN. FROM TO FT.

WELL DEVELOPMENT	
DEVELOPMENT METHOD:	AIR LIFT
TIME DEVELOPING:	4 HOURS
WATER REMOVED:	60 GALLONS
WATER ADDED:	0 GALLONS
WATER CLARITY BEFORE / AFTER DEVELOPMENT	
CLARITY BEFORE:	TURBID
COLOR BEFORE:	LIGHT GRAY
CLARITY AFTER:	SLIGHTLY TURBID
COLOR AFTER:	VERY LIGHT GRAY
ODOR (IF PRESENT):	NONE

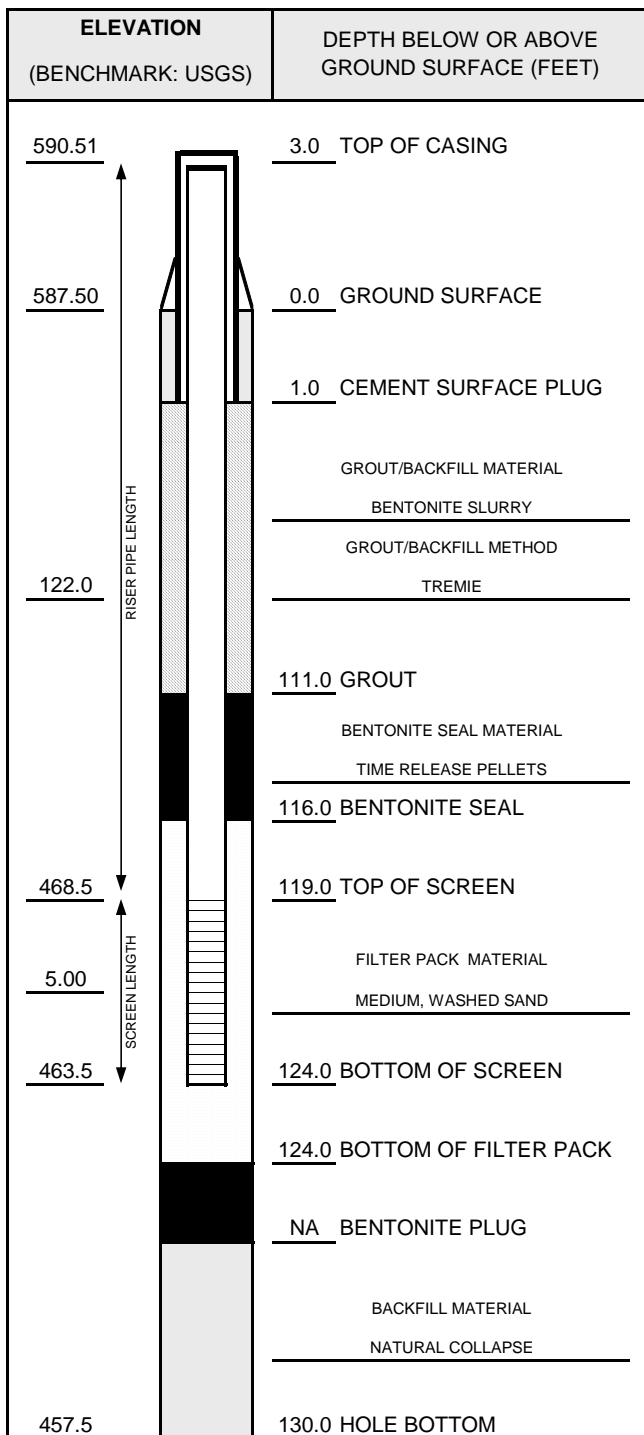
WATER LEVEL SUMMARY				
MEASUREMENT (FEET)			DATE	TIME
DTB BEFORE DEVELOPING:	140.00	T/PVC	6/8/2016	7:20
DTB AFTER DEVELOPING:	140.00	T/PVC	6/8/2016	14:30
SWL BEFORE DEVELOPING:	16.06	T/PVC	6/8/2016	7:20
SWL AFTER DEVELOPING:	15.32	T/PVC	6/8/2016	14:30
OTHER DTB:	140.41	T/PVC	6/9/2016	10:00
OTHER SWL:		T/PVC		

PROTECTIVE CASING DETAILS	
PERMANENT, LEGIBLE WELL LABEL ADDED?	<input checked="" type="checkbox"/> YES <input type="checkbox"/> NO
PROTECTIVE COVER AND LOCK INSTALLED?	<input checked="" type="checkbox"/> YES <input type="checkbox"/> NO
LOCK KEY NUMBER:	3120



WELL CONSTRUCTION DIAGRAM

PROJ. NAME:	DTE Electric Company Belle River Power Plant			WELL ID:	MW-16-04
PROJ. NO:	231828.0003	DATE INSTALLED:	3/8/2016	INSTALLED BY:	A. Knutson
				CHECKED BY:	C. Scieszka



NOTES:

CASING AND SCREEN DETAILS

TYPE OF RISER: 2-INCH PVC

PIPE SCHEDULE: 40

PIPE JOINTS: THREADED O-RINGS

SCREEN TYPE: 2-INCH PVC

SCR. SLOT SIZE: 0.01-INCH

BOREHOLE DIAMETER: 6 IN. FROM 0 TO 124 FT.
4 IN. FROM 124 TO 130 FT.

SURF. CASING DIAMETER: IN. FROM TO FT.
 IN. FROM TO FT.

WELL DEVELOPMENT

DEVELOPMENT METHOD: AIR LIFT

TIME DEVELOPING: 4 HOURS

WATER REMOVED: 288 GALLONS

WATER ADDED: 0 GALLONS

WATER CLARITY BEFORE / AFTER DEVELOPMENT

CLARITY BEFORE: VERY TURBID

COLOR BEFORE: BROWN / GREY

CLARITY AFTER: CLEAR

COLOR AFTER: NONE

ODOR (IF PRESENT): NONE

WATER LEVEL SUMMARY

MEASUREMENT (FEET)			DATE	TIME
DTB BEFORE DEVELOPING:	123.97	T/PVC	3/8/2016	--
DTB AFTER DEVELOPING:	126.45	T/PVC	4/13/2016	9:31
SWL BEFORE DEVELOPING:	13.98	T/PVC	3/15/2016	14:30
SWL AFTER DEVELOPING:	13.46	T/PVC	3/18/2016	7:30
OTHER SWL:	16.91	T/PVC	4/13/2016	9:31
OTHER SWL:		T/PVC		

PROTECTIVE CASING DETAILS

PERMANENT, LEGIBLE WELL LABEL ADDED? ☒ YES ☐ NO

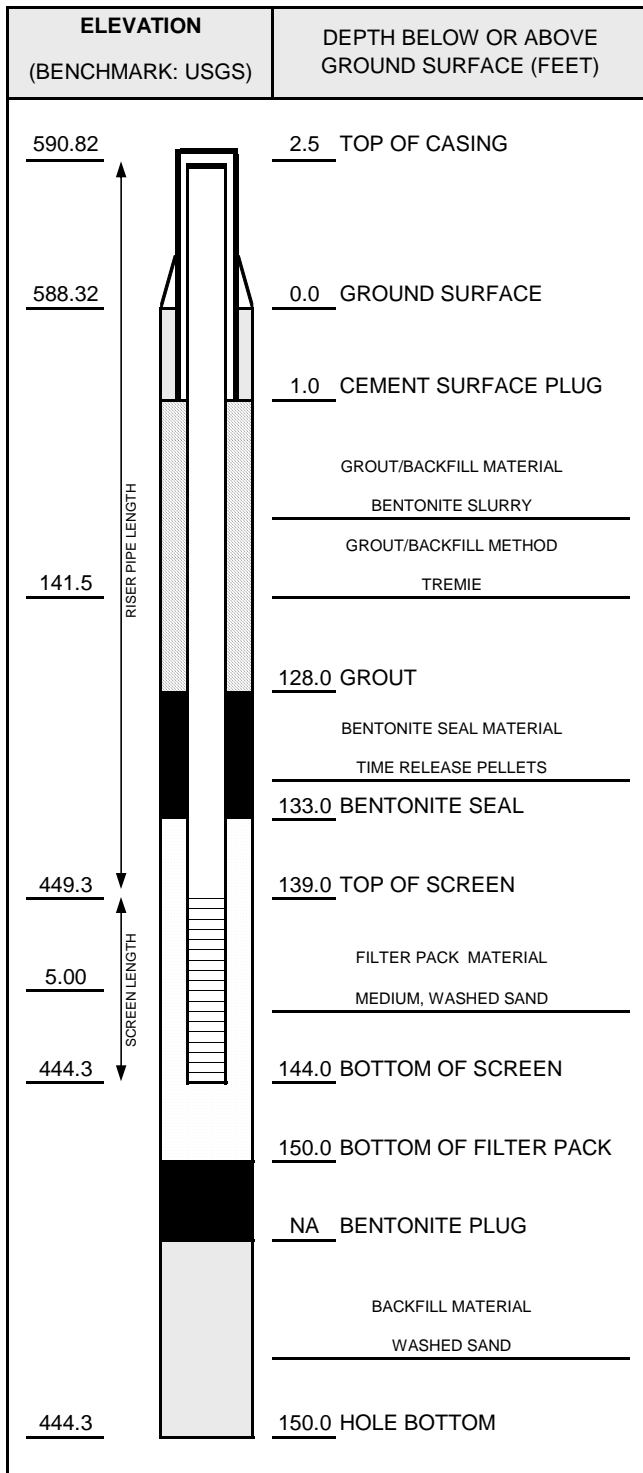
PROTECTIVE COVER AND LOCK INSTALLED? ☒ YES ☐ NO

LOCK KEY NUMBER: 3120



WELL CONSTRUCTION DIAGRAM

PROJ. NAME: DTE Electric Company Belle River Power Plant		WELL ID: MW-16-05
PROJ. NO: 231828.0003	DATE INSTALLED: 3/4/2016	INSTALLED BY: A. Knutson
		CHECKED BY: C. Scieszka



NOTES:

CASING AND SCREEN DETAILS	
TYPE OF RISER:	2-INCH PVC
PIPE SCHEDULE:	40
PIPE JOINTS:	THREADED O-RINGS
SCREEN TYPE:	2-INCH PVC
SCR. SLOT SIZE:	0.01-INCH
BOREHOLE DIAMETER:	6 IN. FROM 0 TO 150 FT.
	IN. FROM TO FT.
SURF. CASING DIAMETER:	IN. FROM TO FT.
	IN. FROM TO FT.

WELL DEVELOPMENT	
DEVELOPMENT METHOD:	AIR LIFT
TIME DEVELOPING:	4 HOURS
WATER REMOVED:	300 GALLONS
WATER ADDED:	0 GALLONS
WATER CLARITY BEFORE / AFTER DEVELOPMENT	
CLARITY BEFORE:	VERY TURBID
COLOR BEFORE:	GREY
CLARITY AFTER:	CLEAR
COLOR AFTER:	NONE
ODOR (IF PRESENT):	NONE

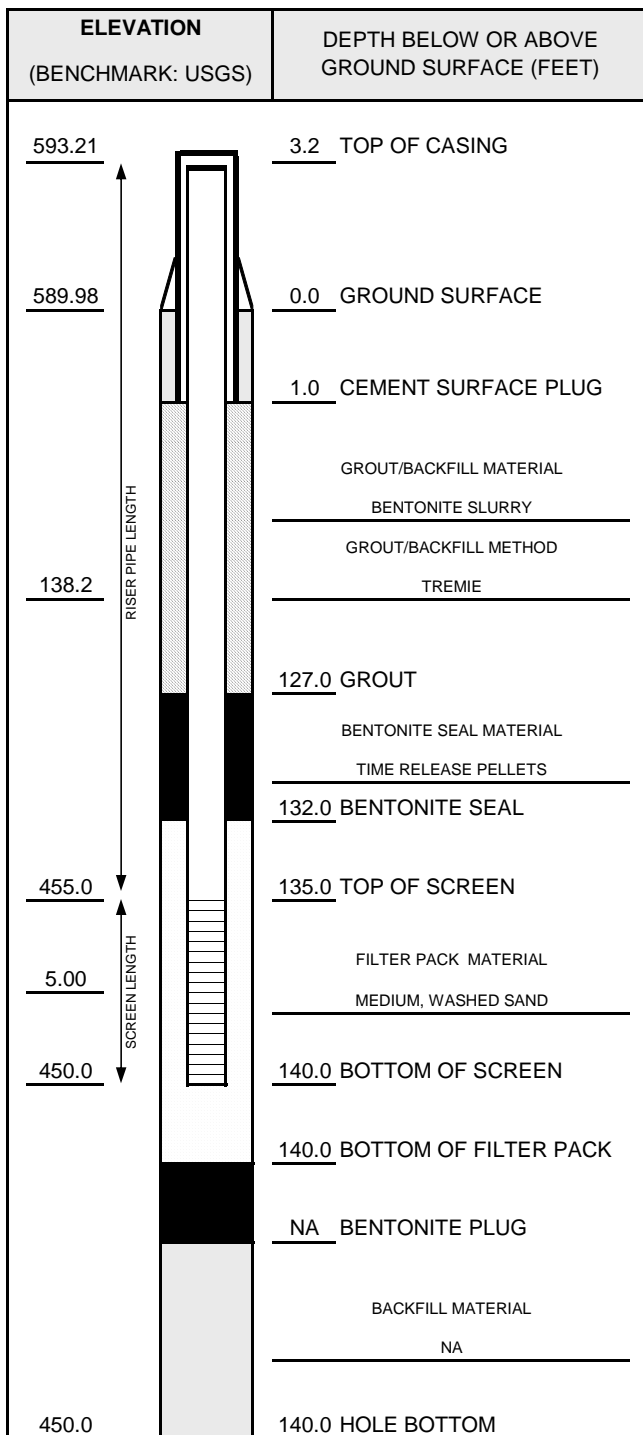
WATER LEVEL SUMMARY				
MEASUREMENT (FEET)			DATE	TIME
DTB BEFORE DEVELOPING:	144.03	T/PVC	3/4/2016	--
DTB AFTER DEVELOPING:	147.16	T/PVC	4/13/2016	9:55
SWL BEFORE DEVELOPING:	13.71	T/PVC	3/15/2016	--
SWL AFTER DEVELOPING:	14.13	T/PVC	3/18/2016	--
OTHER SWL:	16.87	T/PVC	4/13/2016	9:55
OTHER SWL:		T/PVC		

PROTECTIVE CASING DETAILS	
PERMANENT, LEGIBLE WELL LABEL ADDED?	<input checked="" type="checkbox"/> YES <input type="checkbox"/> NO
PROTECTIVE COVER AND LOCK INSTALLED?	<input checked="" type="checkbox"/> YES <input type="checkbox"/> NO
LOCK KEY NUMBER:	3120



WELL CONSTRUCTION DIAGRAM

PROJ. NAME: DTE Electric Company Belle River Power Plant		WELL ID: MW-16-06
PROJ. NO: 231828.0003	DATE INSTALLED: 3/11/2016	INSTALLED BY: A. Knutson
		CHECKED BY: C. Scieszka



CASING AND SCREEN DETAILS	
TYPE OF RISER:	2-INCH PVC
PIPE SCHEDULE:	40
PIPE JOINTS:	THREADED O-RINGS
SCREEN TYPE:	2-INCH PVC
SCR. SLOT SIZE:	0.01-INCH
BOREHOLE DIAMETER:	6 IN. FROM 0 TO 140 FT.
	IN. FROM TO FT.
SURF. CASING DIAMETER:	IN. FROM TO FT.
	IN. FROM TO FT.

WELL DEVELOPMENT	
DEVELOPMENT METHOD:	AIR LIFT
TIME DEVELOPING:	4 HOURS
WATER REMOVED:	50 GALLONS
WATER ADDED:	0 GALLONS
WATER CLARITY BEFORE / AFTER DEVELOPMENT	
CLARITY BEFORE:	VERY TURBID
COLOR BEFORE:	BROWN /GREY
CLARITY AFTER:	CLEAR
COLOR AFTER:	NONE
ODOR (IF PRESENT):	NOT MEASURED

WATER LEVEL SUMMARY				
MEASUREMENT (FEET)			DATE	TIME
DTB BEFORE DEVELOPING:	135.07	T/PVC	3/8/2016	--
DTB AFTER DEVELOPING:	142.85	T/PVC	4/13/2016	10:01
SWL BEFORE DEVELOPING:	19.62	T/PVC	3/15/2016	14:30
SWL AFTER DEVELOPING:	14.90	T/PVC	3/18/2016	7:30
OTHER SWL:	17.65	T/PVC	4/13/2016	10:01
OTHER SWL:		T/PVC		

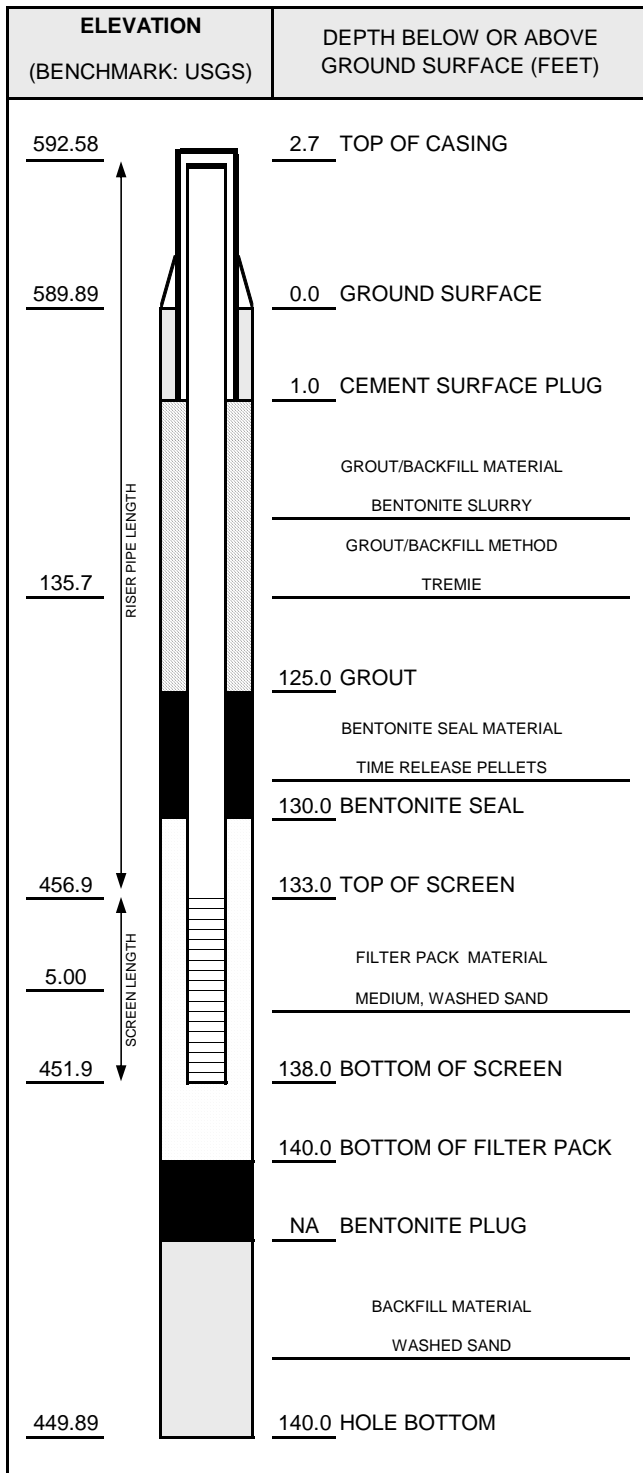
PROTECTIVE CASING DETAILS	
PERMANENT, LEGIBLE WELL LABEL ADDED?	<input checked="" type="checkbox"/> YES <input type="checkbox"/> NO
PROTECTIVE COVER AND LOCK INSTALLED?	<input checked="" type="checkbox"/> YES <input type="checkbox"/> NO
LOCK KEY NUMBER:	3120

NOTES:



WELL CONSTRUCTION DIAGRAM

PROJ. NAME: DTE Electric Company Belle River Power Plant		WELL ID: MW-16-07
PROJ. NO: 231828.0003	DATE INSTALLED: 3/9/2016	INSTALLED BY: A. Knutson
		CHECKED BY: C. Scieszka



NOTES:

CASING AND SCREEN DETAILS	
TYPE OF RISER:	2-INCH PVC
PIPE SCHEDULE:	40
PIPE JOINTS:	THREADED O-RINGS
SCREEN TYPE:	2-INCH PVC
SCR. SLOT SIZE:	0.01-INCH
BOREHOLE DIAMETER:	6 IN. FROM 0 TO 140 FT.
	IN. FROM TO FT.
SURF. CASING DIAMETER:	IN. FROM TO FT.
	IN. FROM TO FT.

WELL DEVELOPMENT	
DEVELOPMENT METHOD:	AIR LIFT
TIME DEVELOPING:	4 HOURS
WATER REMOVED:	120 GALLONS
WATER ADDED:	0 GALLONS
WATER CLARITY BEFORE / AFTER DEVELOPMENT	
CLARITY BEFORE:	VERY TURBID
COLOR BEFORE:	BROWN /GREY
CLARITY AFTER:	CLEAR
COLOR AFTER:	NONE
ODOR (IF PRESENT):	NONE

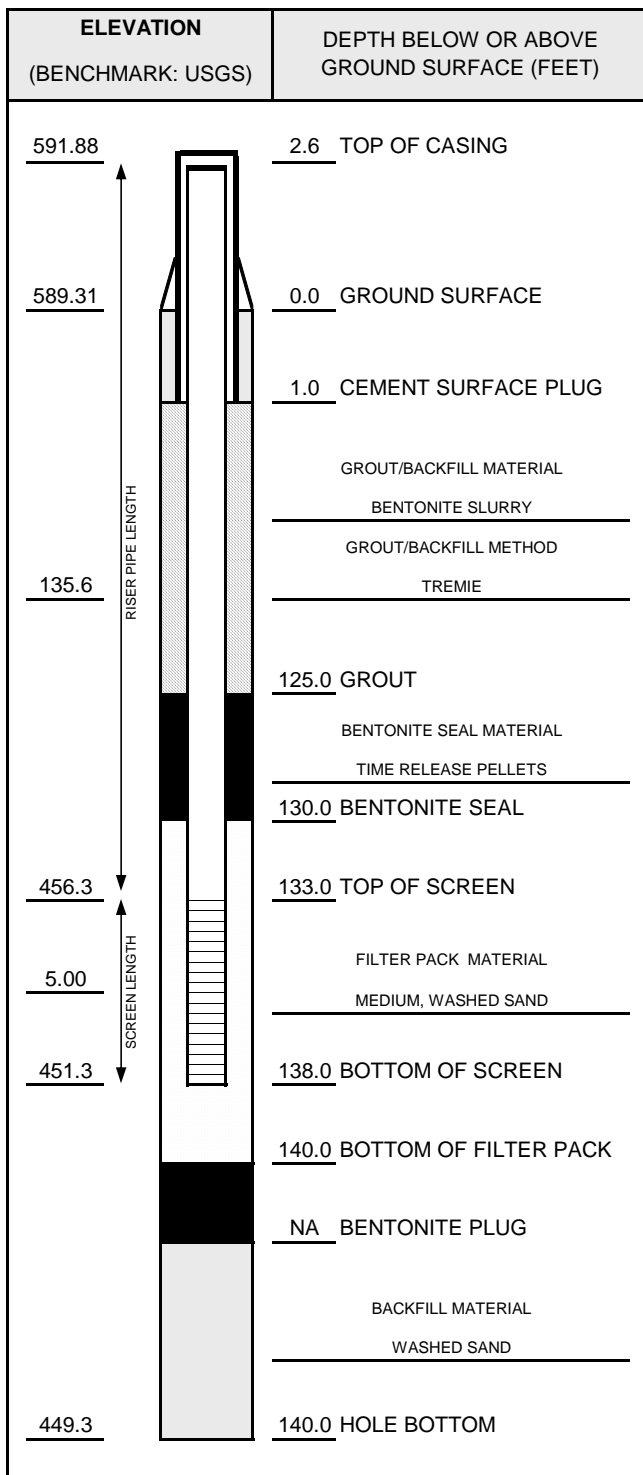
WATER LEVEL SUMMARY				
MEASUREMENT (FEET)			DATE	TIME
DTB BEFORE DEVELOPING:	138.02	T/PVC	3/9/2016	--
DTB AFTER DEVELOPING:	141.19	T/PVC	4/13/2016	11:56
SWL BEFORE DEVELOPING:	14.66	T/PVC	3/15/2016	--
SWL AFTER DEVELOPING:	14.25	T/PVC	3/18/2016	--
OTHER SWL:	16.83	T/PVC	4/13/2016	11:56
OTHER SWL:		T/PVC		

PROTECTIVE CASING DETAILS	
PERMANENT, LEGIBLE WELL LABEL ADDED?	<input checked="" type="checkbox"/> YES <input type="checkbox"/> NO
PROTECTIVE COVER AND LOCK INSTALLED?	<input checked="" type="checkbox"/> YES <input type="checkbox"/> NO
LOCK KEY NUMBER:	3120



WELL CONSTRUCTION DIAGRAM

PROJ. NAME: DTE Electric Company Belle River Power Plant		WELL ID: MW-16-08
PROJ. NO: 231828.0003	DATE INSTALLED: 3/10/2016	INSTALLED BY: A. Knutson
		CHECKED BY: C. Scieszka



NOTES:

CASING AND SCREEN DETAILS	
TYPE OF RISER:	2-INCH PVC
PIPE SCHEDULE:	40
PIPE JOINTS:	THREADED O-RINGS
SCREEN TYPE:	2-INCH PVC
SCR. SLOT SIZE:	0.01-INCH
BOREHOLE DIAMETER:	6 IN. FROM 0 TO 140 FT.
	IN. FROM TO FT.
SURF. CASING DIAMETER:	IN. FROM TO FT.
	IN. FROM TO FT.

WELL DEVELOPMENT	
DEVELOPMENT METHOD:	AIR LIFT
TIME DEVELOPING:	4 HOURS
WATER REMOVED:	125 GALLONS
WATER ADDED:	0 GALLONS
WATER CLARITY BEFORE / AFTER DEVELOPMENT	
CLARITY BEFORE:	VERY TURBID
COLOR BEFORE:	BROWN /GREY
CLARITY AFTER:	CLEAR
COLOR AFTER:	NONE
ODOR (IF PRESENT):	NONE

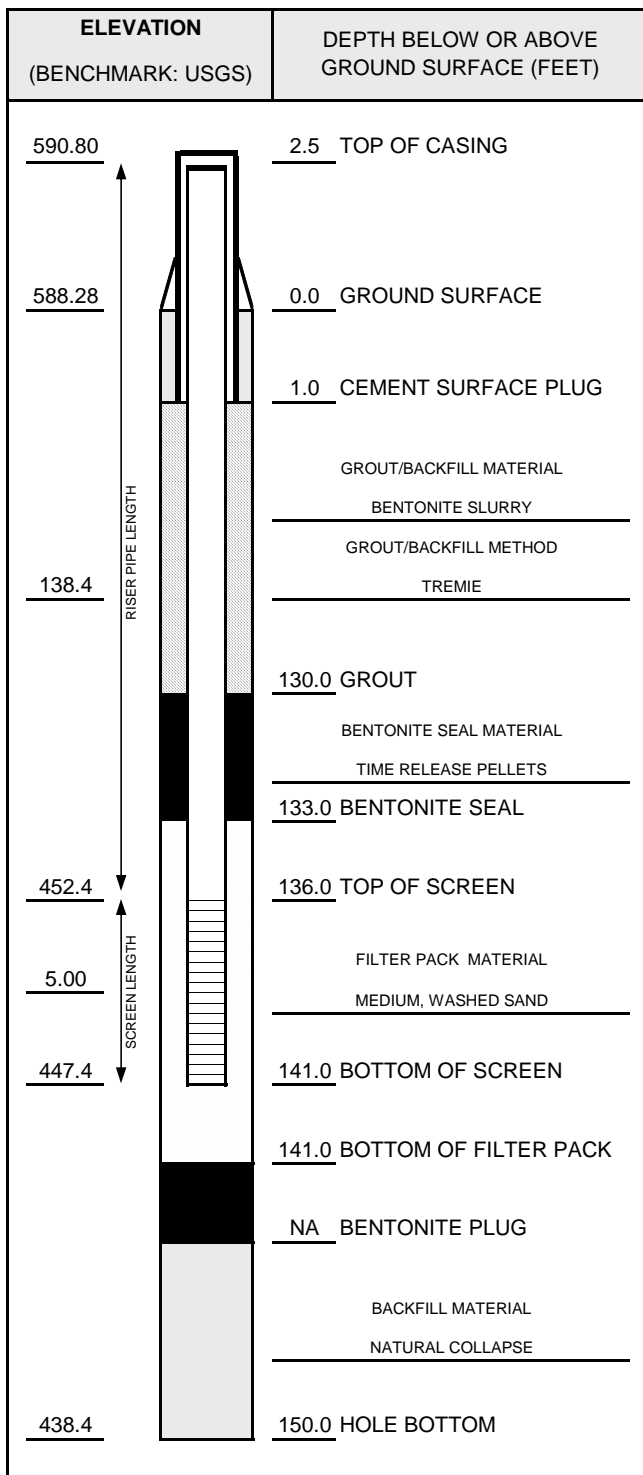
WATER LEVEL SUMMARY				
MEASUREMENT (FEET)			DATE	TIME
DTB BEFORE DEVELOPING:	137.94	T/PVC	3/11/2016	--
DTB AFTER DEVELOPING:	140.80	T/PVC	4/13/2016	12:00
SWL BEFORE DEVELOPING:	14.23	T/PVC	3/15/2016	14:30
SWL AFTER DEVELOPING:	14.23	T/PVC	3/18/2016	7:30
OTHER SWL:	15.79	T/PVC	4/13/2016	12:00
OTHER SWL:		T/PVC		

PROTECTIVE CASING DETAILS	
PERMANENT, LEGIBLE WELL LABEL ADDED?	<input checked="" type="checkbox"/> YES <input type="checkbox"/> NO
PROTECTIVE COVER AND LOCK INSTALLED?	<input checked="" type="checkbox"/> YES <input type="checkbox"/> NO
LOCK KEY NUMBER:	3120



WELL CONSTRUCTION DIAGRAM

PROJ. NAME: DTE Electric Company Belle River Power Plant		WELL ID: MW-16-09
PROJ. NO: 231828.0003	DATE INSTALLED: 6/2/2016	INSTALLED BY: J. Reed
		CHECKED BY: M. Powers



NOTES:

CASING AND SCREEN DETAILS	
TYPE OF RISER:	2-INCH PVC
PIPE SCHEDULE:	40
PIPE JOINTS:	THREADED O-RINGS
SCREEN TYPE:	2-INCH PVC
SCR. SLOT SIZE:	0.01-INCH
BOREHOLE DIAMETER:	6 IN. FROM 0 TO 150 FT.
	IN. FROM TO FT.
SURF. CASING DIAMETER:	IN. FROM TO FT.
	IN. FROM TO FT.

WELL DEVELOPMENT	
DEVELOPMENT METHOD:	AIR LIFT
TIME DEVELOPING:	7 HOURS
WATER REMOVED:	30 GALLONS
WATER ADDED:	0 GALLONS
WATER CLARITY BEFORE / AFTER DEVELOPMENT	
CLARITY BEFORE:	TURBID
COLOR BEFORE:	GRAY
CLARITY AFTER:	VERY TURBID
COLOR AFTER:	GRAY
ODOR (IF PRESENT):	NONE

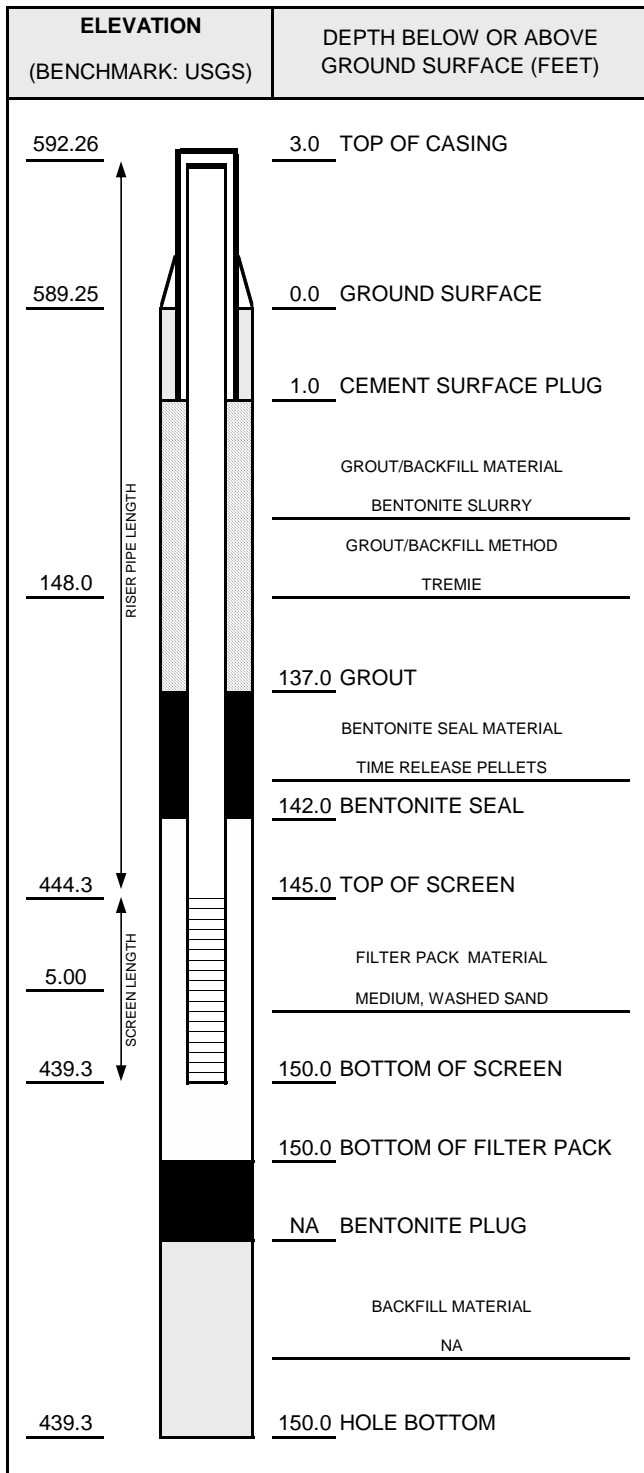
WATER LEVEL SUMMARY				
MEASUREMENT (FEET)			DATE	TIME
DTB BEFORE DEVELOPING:	140.00	T/PVC	6/7/2016	12:00
DTB AFTER DEVELOPING:	140.00	T/PVC	6/8/2016	10:25
SWL BEFORE DEVELOPING:	7.00	T/PVC	6/7/2016	12:00
SWL AFTER DEVELOPING:	117.42	T/PVC	6/8/2016	10:25
OTHER SWL:	16.76	T/PVC	6/9/2016	15:13
OTHER DTB:	144.30	T/PVC	6/9/2016	15:13

PROTECTIVE CASING DETAILS	
PERMANENT, LEGIBLE WELL LABEL ADDED?	<input checked="" type="checkbox"/> YES <input type="checkbox"/> NO
PROTECTIVE COVER AND LOCK INSTALLED?	<input checked="" type="checkbox"/> YES <input type="checkbox"/> NO
LOCK KEY NUMBER:	3120



WELL CONSTRUCTION DIAGRAM

PROJ. NAME: DTE Electric Company Belle River Power Plant		WELL ID: MW-16-10
PROJ. NO: 231828.0003	DATE INSTALLED: 6/6/2016	INSTALLED BY: J. Reed
		CHECKED BY: M. Powers



NOTES:

CASING AND SCREEN DETAILS	
TYPE OF RISER:	2-INCH PVC
PIPE SCHEDULE:	40
PIPE JOINTS:	THREADED O-RINGS
SCREEN TYPE:	2-INCH PVC
SCR. SLOT SIZE:	0.01-INCH
BOREHOLE DIAMETER:	6 IN. FROM 0 TO 150 FT.
	IN. FROM TO FT.
SURF. CASING DIAMETER:	IN. FROM TO FT.
	IN. FROM TO FT.

WELL DEVELOPMENT	
DEVELOPMENT METHOD:	AIR LIFT
TIME DEVELOPING:	4.5 HOURS
WATER REMOVED:	85 GALLONS
WATER ADDED:	60 GALLONS
WATER CLARITY BEFORE / AFTER DEVELOPMENT	
CLARITY BEFORE:	VERY TURBID
COLOR BEFORE:	DARK GRAY
CLARITY AFTER:	VERY TURBID
COLOR AFTER:	DARK GRAY
ODOR (IF PRESENT):	NONE

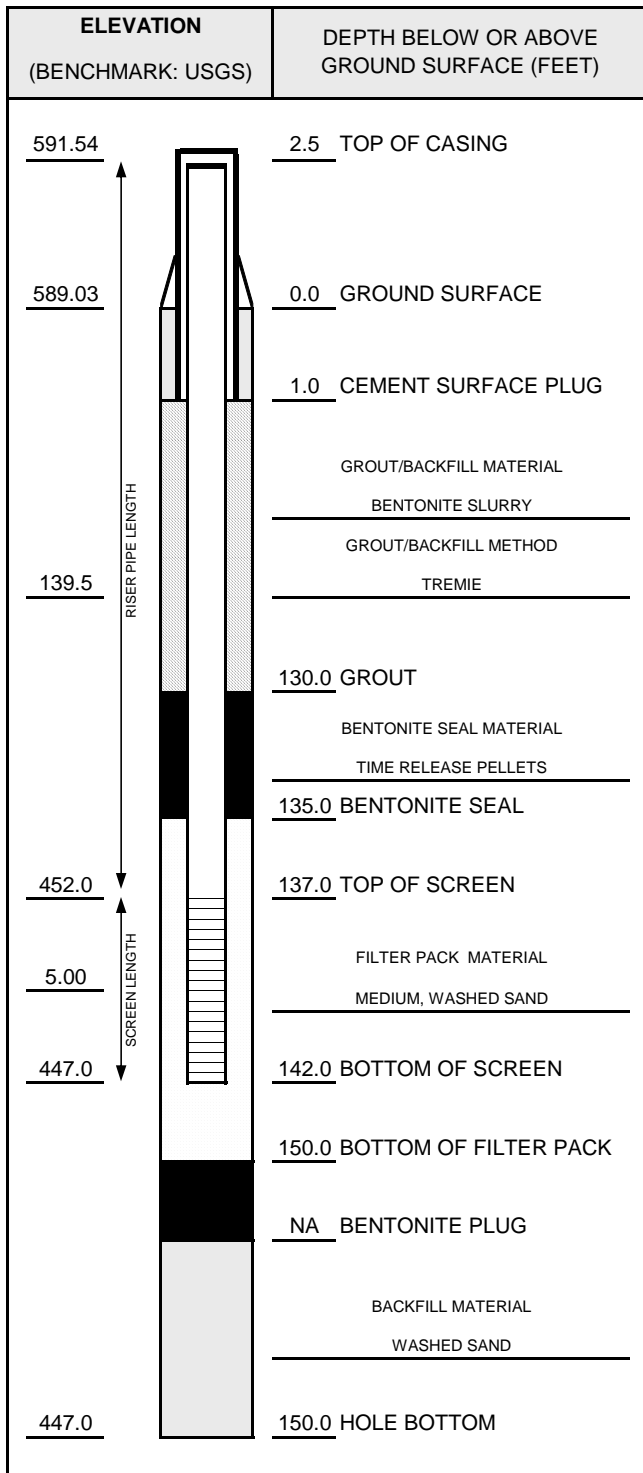
WATER LEVEL SUMMARY				
MEASUREMENT (FEET)			DATE	TIME
DTB BEFORE DEVELOPING:	151.30	T/PVC	6/9/2016	7:45
DTB AFTER DEVELOPING:	152.28	T/PVC	6/9/2016	16:50
SWL BEFORE DEVELOPING:	17.80	T/PVC	6/9/2016	7:45
SWL AFTER DEVELOPING:	59.44	T/PVC	6/9/2016	16:50
OTHER SWL:		T/PVC		
OTHER SWL:		T/PVC		

PROTECTIVE CASING DETAILS	
PERMANENT, LEGIBLE WELL LABEL ADDED?	<input checked="" type="checkbox"/> YES <input type="checkbox"/> NO
PROTECTIVE COVER AND LOCK INSTALLED?	<input checked="" type="checkbox"/> YES <input type="checkbox"/> NO
LOCK KEY NUMBER:	3120



WELL CONSTRUCTION DIAGRAM

PROJ. NAME: DTE Electric Company Belle River Power Plant		WELL ID: MW-16-11
PROJ. NO: 231828.0003	DATE INSTALLED: 6/7/2016	INSTALLED BY: J. Reed
		CHECKED BY: M. Powers



CASING AND SCREEN DETAILS	
TYPE OF RISER:	2-INCH PVC
PIPE SCHEDULE:	40
PIPE JOINTS:	THREADED O-RINGS
SCREEN TYPE:	2-INCH PVC
SCR. SLOT SIZE:	0.01-INCH
BOREHOLE DIAMETER:	6 IN. FROM 0 TO 150 FT.
	IN. FROM TO FT.
SURF. CASING DIAMETER:	IN. FROM TO FT.
	IN. FROM TO FT.

WELL DEVELOPMENT	
DEVELOPMENT METHOD:	AIR LIFT
TIME DEVELOPING:	3 HOURS
WATER REMOVED:	84 GALLONS
WATER ADDED:	60 GALLONS
WATER CLARITY BEFORE / AFTER DEVELOPMENT	
CLARITY BEFORE:	VERY TURBID
COLOR BEFORE:	DARK GRAY
CLARITY AFTER:	VERY TURBID
COLOR AFTER:	GRAY
ODOR (IF PRESENT):	NONE

WATER LEVEL SUMMARY				
MEASUREMENT (FEET)			DATE	TIME
DTB BEFORE DEVELOPING:	141.36	T/PVC	6/9/2016	12:35
DTB AFTER DEVELOPING:	142.00	T/PVC	6/9/2016	15:45
SWL BEFORE DEVELOPING:	9.65	T/PVC	6/9/2016	12:35
SWL AFTER DEVELOPING:	116.00	T/PVC	6/9/2016	15:45
OTHER SWL:	16.67	T/PVC	6/21/2016	7:45
OTHER SWL:		T/PVC		

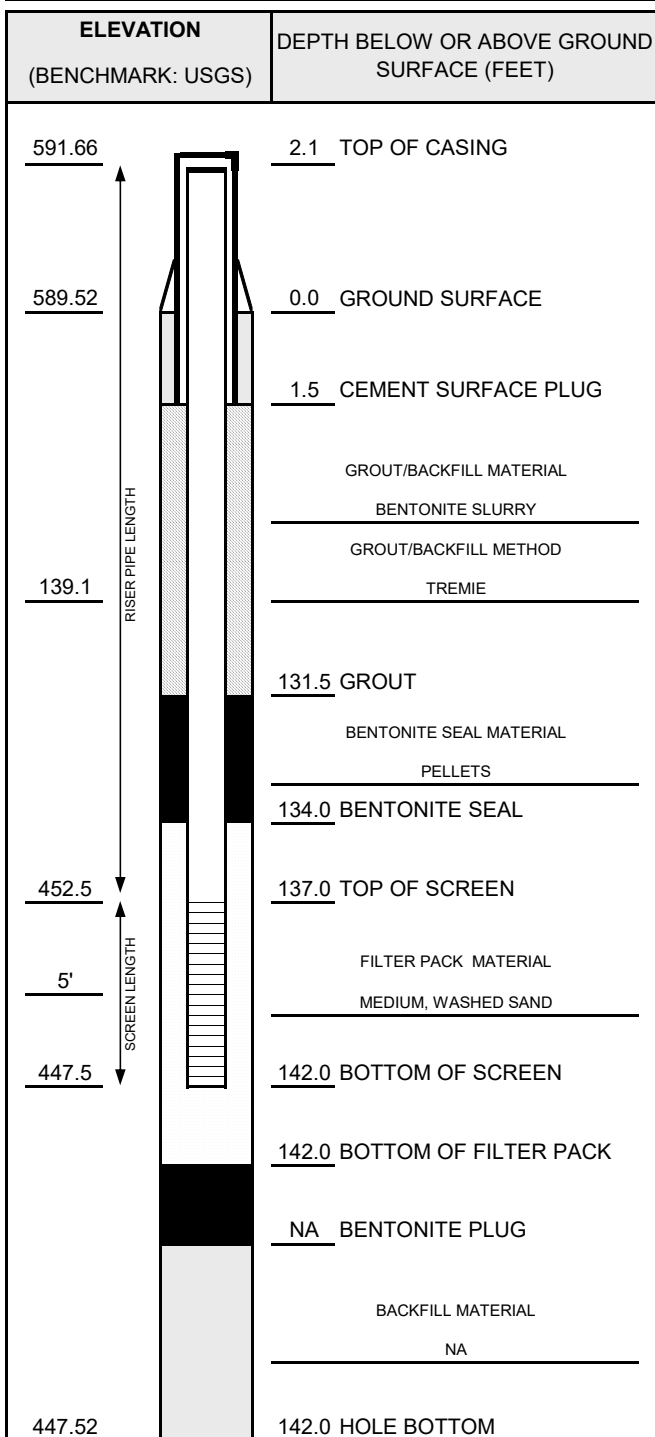
PROTECTIVE CASING DETAILS	
PERMANENT, LEGIBLE WELL LABEL ADDED?	<input checked="" type="checkbox"/> YES <input type="checkbox"/> NO
PROTECTIVE COVER AND LOCK INSTALLED?	<input checked="" type="checkbox"/> YES <input type="checkbox"/> NO
LOCK KEY NUMBER:	3120

NOTES:



WELL CONSTRUCTION DIAGRAM

PROJ. NAME:	DTE Electric Company Belle River Power Plant			WELL ID:	MW-16-11A
PROJ. NO:	265996.0003	DATE INSTALLED:	5/12/2017	INSTALLED BY:	Jake Krenz
					CHECKED BY: C. Scieszka



NOTES:

CASING AND SCREEN DETAILS

TYPE OF RISER: 2-INCH PVCPIPE SCHEDULE: 40PIPE JOINTS: THREADED O-RINGSSOLVENT USED? NOSCREEN TYPE: 2-INCH PVCSCR. SLOT SIZE: 0.01-INCHBOREHOLE DIAMETER: 6 IN. FROM 0 TO 142 FT.NA IN. FROM NA TO NA FT.SURF. CASING DIAMETER: NA IN. FROM NA TO NA FT.NA IN. FROM NA TO NA FT.

WELL DEVELOPMENT

DEVELOPMENT METHOD: AIR LIFTTIME DEVELOPING: 3 HOURSWATER REMOVED: 110 GALLONSWATER ADDED: 0 GALLONS

WATER CLARITY BEFORE / AFTER DEVELOPMENT

CLARITY BEFORE: Very TurbidCOLOR BEFORE: Dark GrayCLARITY AFTER: Very TurbidCOLOR AFTER: Light GrayODOR (IF PRESENT): None

WATER LEVEL SUMMARY

MEASUREMENT (FEET)			DATE	TIME
DTB BEFORE DEVELOPING:	141.98	T/PVC	5/15/2017	0838
DTB AFTER DEVELOPING:	145.45	T/PVC	5/15/2017	1612
SWE BEFORE DEVELOPING:	17.79	T/PVC	5/15/2017	0838
SWE AFTER DEVELOPING:	90.12	T/PVC	5/15/2017	1612
OTHER SWE:		T/PVC		
OTHER SWE:		T/PVC		

PROTECTIVE CASING DETAILS

PERMANENT, LEGIBLE WELL LABEL ADDED? ☒ YES ☐ NOPROTECTIVE COVER AND LOCK INSTALLED? ☒ YES ☐ NOLOCK KEY NUMBER: 3120

Appendix D
Subsurface Investigation and Foundation
Report, Bechtel, 1976

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SUBSURFACE INVESTIGATION AND FOUNDATION REPORT

THE DETROIT



EDISON COMPANY

**BELLE RIVER
UNITS 1 & 2
JOB 10539**

VOLUME 1 OF 2

GEOLOGY AND SOIL PROPERTIES

P. H. COOK

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**BECHTEL
ANN ARBOR, MICHIGAN**



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ABSTRACT

This report presents the results of an extensive subsurface investigation program for the Detroit Edison Company at the Belle River Project site. The proposed project consists of a two-unit coal fired plant and the associated coal handling facilities. The study was directed at evaluation of the geologic and ground water conditions and the development of soil parameters for design and construction of the proposed facilities.

The evaluations presented in this report consist of a review of previous investigations, a literature review, and detailed subsurface investigation and laboratory testing programs. This investigation confirmed the suitability of the site for the proposed facilities and gave the soil mechanics information necessary for planning, design and construction of plant facilities.

PREFACE

This report was prepared by Geotechnical Services in the Ann Arbor Office of Bechtel. The soils sections of this report were prepared by D.R. Gle and the geology sections by J.V. Mrakovich. J.B. Givens also contributed to the soil data evaluations. The Ann Arbor Office review and approval was by S. Mackay and G.T. LeFevre, Engineering Geology Supervisors, and S.S. Afifi, Soils Engineering Supervisor. The San Francisco H & CF review and approval was by M.J. Adair, Chief Geologist, and W.R. Ferris, Chief Soils Engineer. The report was also reviewed by S.L. Blue, Geotechnical Services Manager, H & CF Division, Ann Arbor, Michigan. The report was collated by A.R. Rossmann, Drafting Supervisor, Ann Arbor.

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A	Pore pressure parameter (Skempton)
C_c	Compression index
C_r	Swelling index
C_v	Coefficient of consolidation
c	Cohesion intercept for total stresses from Mohr-Coulomb Relationship
c'	Cohesion intercept for effective stresses from Mohr-Coulomb Relationship
\overline{CU}	Consolidated-undrained triaxial compression test with pore pressure measurement
D_{50}	Grain size analysis: diameter at which 50% of the sample is finer
E	Young's modulus of elasticity as determined from the initial tangent modulus of the stress-strain curve
e_o	Initial void ratio
k	Permeability
ksf	Kips per square foot
LL	Liquid limit
PI	Plasticity index ($LL - PL$)
P_c	Preconsolidation pressure
PL	Plastic limit
\bar{p}	Effective vertical pressure
p_o	In-situ effective overburden pressure
p	Stress point, $(\sigma_1 + \sigma_3)/2$
p'	Stress point, $(\bar{\sigma}_1 + \bar{\sigma}_3)/2$

pcf	Pounds per cubic foot
psf	Pounds per square foot
q	Stress point, $(\sigma_1 - \sigma_3)/2$
Qu	Unconfined compression test
S	Shear strength
SPT	Standard penetration test (ASTM D 1586)
S_u	Undrained shear strength
UU	Unconsolidated-undrained triaxial compression test
w_o	Initial moisture content
w_f	Moisture content after consolidation (\overline{CU} test)
γ_d	Dry density
γ_t	Total density
γ_{tf}	Total density after consolidation (\overline{CU} test)
ϵ	Axial strain
σ	Total normal stress on failure plane at failure
σ'	Effective normal stress on failure plane at failure
σ_o	Confining pressure (unconsolidated-undrained triaxial test)
$\overline{\sigma}_3$	Effective confining pressure (consolidated-undrained triaxial test)
ϕ	Angle of internal friction for total stresses
ϕ'	Angle of internal friction for effective stresses
τ	Drained shear strength

1.0 INTRODUCTION

The Detroit Edison Company's proposed Belle River Project consists of a two-unit coal fired power plant and the associated coal handling facilities. The project site is located in St. Clair County, Michigan, between the cities of St. Clair and Marine City. Figure 1 shows the state of Michigan with the site location indicated. This site is just west of the existing Detroit Edison Company St. Clair Power Plant. A general site plan showing all of the existing and proposed facilities is shown in Figure 2.

The coal handling facilities will include a docking facility, transfer houses, radial stackers, underground coal reclaimers and a conveyor system, along with both primary and secondary coal storage areas. The proposed power block will consist of two boiler buildings, two turbine buildings, four precipitators, a smoke stack, service building, administration building, warehouse, and miscellaneous other tanks and treatment basins. Other facilities away from the power block include a switchyard and intake and discharge structures.

The project facilities are superimposed on the boring location plan and are shown in Figure 3. The area proposed

for fly ash disposal (Figure 4) has also been considered in the evaluations.

Volume 1 of this report contains the final results of the geological evaluations, laboratory soil testing, soil properties evaluations, and the development of the soil engineering parameters to be used for the entire Belle River 1 & 2 Project area. The results of previous investigations supplied by The Detroit Edison Company are given in Appendix A. Bechtel soil/rock borings are presented in Appendix B, along with a tabulated summary and a key to the notation used on the boring logs.

Volume 2 contains Appendices C and D which include all of the laboratory test results. Appendix C contains the results of laboratory tests performed by Goldberg-Zoino and Associates while Appendix D contains the results of laboratory tests conducted by U. W. Stoll and Associates.

The engineering design criteria for the various portions of this project will not be addressed in this report. Design criteria will be addressed upon reactivation of the project when more details are known about the proposed facilities and the final location of structures.

2.0 SCOPE OF WORK

The purpose of the subsurface investigation and laboratory testing program was to evaluate the soil, rock, and ground water conditions at the site in order to provide sufficient information for planning, design, and construction of the various plant facilities. Upon reactivation of this project, foundation systems and parameters for the various foundation design, construction, and soil structure interaction schemes will be developed based on this information.

This report is based on a review of previous investigations, geologic research, ground water studies, soil and rock drilling and sampling, and a laboratory testing program.

3.0 SUBSURFACE EXPLORATION

3.1 PREVIOUS EXPLORATION FOR THE EXISTING ST. CLAIR PLANT

Borings were made for various structures and facilities of the St. Clair power plant during 1950, 1959, and 1965.

These are contained in a report prepared under the direction of W. S. Housel and the University of Michigan's Office of Research Administration, Soil Mechanics Laboratory for the addition to St. Clair Unit No. 7. The 1950 borings were generally in the area of the main plant while the 1959 and 1965 borings were made for the dock area and yard conveyor, respectively.

Included in the Housel report are the individual boring log profiles of borings made during 1965 and composite subsoil analysis profiles extending to bedrock. It also contains information on comparisons with borings made in the same area during 1950 and 1959. Through 1965, a total of 28 borings were drilled east of M-29 along the shore of the St. Clair River and within the St. Clair plant area. Seven borings were drilled west of M-29 along the yard conveyor. The Housel report and other borings in the area made available to Bechtel are included in Appendix A of this volume.

3.2 EXPLORATION FOR THE PROPOSED BELLE RIVER PROJECT

3.2.1 General

The existing docking facility was rebuilt to accommodate larger ships approximately 105 feet wide and 1000 feet long having a draft of about 27.5 feet. The existing conveyor system serving the present St. Clair units will remain in place. A new conveyor system will begin at the docking facility and parallel the existing system to Highway M-29, where it will bridge across M-29 and bisect the new primary coal storage area.

From the primary coal storage area, the conveyor system crosses over the Detroit and Port Huron Railroad tracks and turns northward towards the main plant area and the secondary coal storage pile. The conveyor will then split, with one conveyor going west into the main plant and the other going east, over the railroad tracks, to the secondary coal storage area. Also located along the conveyor system are various transfer houses and stacker-reclaimers as shown in Figures 2, 3 and 4.

The primary coal storage area is separated into three storage locations covering an area of approximately 75

acres. There are two main dead storage piles to the north and south sides of the conveyor, and a smaller live storage pile between the conveyor and the south dead coal storage. An approximate capacity of 2.5 million tons of coal can be stored at these locations.

The secondary coal storage area will consist of a single coal pile located just east of the main plant. This pile will cover an area of approximately 20 acres, and will have a total dead storage capacity of approximately one million tons.

In addition, there will be a large fly ash disposal area to the northwest of the main plant. In general, this area is bounded by the existing Remer Road, King Road, the Detroit and Port Huron Railroad, and a line about one-half mile north of and parallel to Puttygut Road.

3.2.2 Details of Exploration

The subsurface exploration program and foundation evaluation were developed by Bechtel. The drilling, which was done by Raymond International, began in November 1973 and ended in August 1975. Bechtel soil engineer(s) and Bechtel

engineering geologist(s) supervised field operations and recorded field logs of the drilling, sampling, and field testing of the foundation materials. Logs of all borings were prepared by Bechtel and are included in Appendix B.

In the docking area, ten 5-inch diameter exploratory borings were drilled and sampled to bedrock. In addition, 74 other rotary wash borings were drilled along the conveyor system, the coal storage areas, and the main plant area. A total of 36 borings were drilled in the fly ash disposal area northwest of the main plant. These borings were located on approximately a 1,000 foot grid and extended to depths of from 70 to 140 feet. Undisturbed samples were obtained in selected borings while split spoon samples were obtained in all of the remaining borings to verify the subsurface materials and consistency.

Throughout this investigation, undisturbed samples were generally taken at 10-foot intervals with standard 3-inch O. D. Shelby tubes. From a depth of approximately 15 to 70 feet, some difficulty was encountered in retaining the very soft clayey soils in the standard Shelby tube, and the Osterberg Sampler was used to recover samples within this depth. Generally, this sampler enabled adequate recovery.

Material in each undisturbed sample was visually classified by the Bechtel field engineer. The tubes were then sealed with a double layer of wax, labeled, and selected tubes were shipped to the laboratory.

Drive samples were obtained at the alternate 10-foot intervals between undisturbed samples using a standard split spoon sampler. This procedure (ASTM D 1586) utilizes a 140-pound hammer falling 30 inches to drive a 1-3/8 inch I.D. split spoon sampler 18 inches. Blows required to advance the sampler through each six inches were recorded. The standard penetration test (SPT) blowcount is the number of blows for the last foot the sampler is driven. Standard penetration test blowcounts are given on the boring logs. In the exceptionally hard materials found at depths of approximately 130 to 135 feet, refusal was considered to have been attained when 100 blows were delivered for any six inch driving increment.

Material recovered in the split spoon sampler was visually classified by the engineer, and a portion of the sample was then stored in a glass jar. Selected jar samples were sent to the testing laboratory for classification.

Classifications made in the field were compared with the laboratory classification during proofreading of each field log and the appropriate corrections were then made on the final boring log. The unified soil classification for each sample is as shown on the boring logs given in Appendix B.

Rock cores were obtained in areas where the foundation system has a possibility of bearing on bedrock. Specified holes were cored a minimum of 20 feet into rock to assure positive penetration through the overburden and to obtain samples to evaluate the competency of the rock.

Cores were placed in partitioned core boxes (each holding about 15 feet of core), classified, and stored at the site. Bechtel geologists prepared logs of the rock core portions of each hole.

At the completion of the investigation, the remaining sample jars, Shelby tube samples, and rock core samples were stored at the St. Clair Power Plant.

4.0 SITE CONDITIONS

This section addresses the geology and generalized subsurface soil conditions for this site. The geological studies were based on a literature review, evaluation of site boring logs, and ground water measurements. The soil conditions were developed from an evaluation of the boring logs and laboratory soil tests, along with geologic and ground water evidence and also a review of previous investigations.

4.1 GEOLOGY

4.1.1 Regional Geology

The site is located in the Lower Peninsula of Michigan on the southeastern margin of the Michigan Basin (Figure 5). This basin is a broad, shallow, tectonic structure approximately 300 miles in diameter and containing up to 14,000 feet of Paleozoic sediments in its central portion near Mount Pleasant. Thickening of strata toward the center of the basin indicates that the Lower Peninsula was a region of slow subsidence with almost continuous deposition throughout the Paleozoic. A large part of basin development occurred during Silurian, Middle and Upper Devonian time

when about two-thirds of the total Paleozoic sequence was deposited. Subsidence apparently ceased at the close of Jurassic time, about 135 million years ago, since no rocks of younger age are known to exist in the region.

During the Pleistocene, continental glaciers advanced and retreated across the region many times, modifying the bedrock topography and covering it with glacial drift, which now comprises almost all natural topographic features at the site and in the Lower Peninsula.

Faulting is not common to the region, and no known faults occur near the site. The nearest mapped faulting occurs in the area of the Chatham Sag in eastern Ontario, about 15 miles southeast of the site; however, it is considered inactive (Ref 1).

The Lower Peninsula of Michigan is an area of low seismic activity where only six earthquakes have been recorded in historic time. None of these earthquakes can be related to mapped faults or tectonic structures in the Michigan Basin. According to the seismic risk map of the U.S. (Ref 2), the site is located in Zone 1 which corresponds to Intensities V and VI (Modified Mercalli Scale of 1931), where only minor damage should be expected.

4.1.2 Site Geology

The site is located in St. Clair County, Michigan, 3.5 miles south of the city of St. Clair on an intermorainal glacial lake plain (Figure 6) whose ground surface varies little above or below 587 feet in elevation.

These glacial lake deposits vary in thickness from 125 to 170 feet within the explored area of the site where they overlie an irregular bedrock surface (Figure 7). The underlying bedrock consists of about 4,600 feet of Paleozoic sedimentary rocks whose uppermost unit is the Bedford Shale formation of Mississippian-Devonian Age. The Paleozoic rocks are underlain by metamorphic, igneous, and sedimentary rock of Precambrian Age (Ref 3).

Overburden materials consist primarily of unconsolidated gray to brown, soft to stiff silt and silty clays with scattered fine sand lenses. Figure 8 shows overburden thickness contours throughout the site area and the cross sections of Figure 9, A through N, show local detailed descriptions of site material.

The most prominent feature of the bedrock topography is a generally north-south trending erosional channel in the

vicinity of the proposed plant. Subsurface profiles (Figure 9, A through N), normal to and along the trend of the channel, show an associated sand deposit whose known maximum thickness is about 60 feet. Generally, the sand appears to be in contact with the bedrock surface and thins rapidly, or becomes absent, away from the channel. As evidenced by the drill hole logs, the sand occurs sporadically elsewhere across the site. Sand thickness and top of sand contour maps (Figures 10 and 11, respectively), as well as the cross sections in Figure 9, A through N, show that the location of these sand deposits is controlled mainly by the bedrock surface. The deposits generally fill low areas on this bedrock surface, suggesting the basal sand is glaciofluvial outwash in origin and represents some of the first material deposited on bedrock by meltwaters from nearby glaciers.

Except for the basal glaciofluvial sand, all other glacial material underlying the site appears to be glaciolacustrine silty clays and silts with local sand lenses.

Bedrock at the site is the Bedford Shale formation of Mississippian-Devonian Age. The rock, cored to a maximum depth of 50 feet, consists of light to dark gray shale varying from soft to firm. The soft shale in the upper

bedrock sequence is generally weathered and highly fractured. The firm shale below is occasionally fractured, but local vein quartz infilling has strengthened the rock by acting as a cementing agent. The estimated top of firm rock (base of the weathered portion) is shown on the subsurface profiles (Figure 9, A through N).

Rock stratigraphy below a depth of 50 feet to the top of the Niagara group was interpreted from logs of five abandoned wildcat oil and gas wells located on the site (Figure 12). The remainder of the Paleozoic interval was interpolated from nearby stratigraphic cross sections (Ref 4) and the Michigan Geological Survey Annual Statistical Summary No. 18, Michigan's Oil and Gas Fields, 1972 (Ref 5). This rock stratigraphy is summarized in the geologic column in Figure 13.

4.1.3 Ground Water

The site is underlain by relatively impermeable glaciolacustrine, silty clays and silts ranging in thickness from 125 to 170 feet with local lenses of glaciofluvial sands. These sand lenses are moderately permeable but are too small to store or transmit much water. Beneath portions

of the site, a basal, glaciofluvial, compact sand and silty sand is encountered immediately above the bedrock surface. These sands attain a known maximum thickness of about 60 feet in the vicinity of the proposed plant structures. Water losses, occurring in these basal sands during the site exploration drilling program, indicate they are relatively permeable. Locally, throughout the region surrounding the site, these sands yield enough ground water for domestic and farm use (Ref 6).

A zone of highly fractured shale, between the top of rock and the top of firm rock is moderately permeable. The highly fractured shale ranges in thickness from zero feet to over 45 feet in rock cores, and is indicated on subsurface profiles in Figure 9, A through N. The permeable shale zone and the basal glaciofluvial sands probably act as a single aquifer where they are in direct contact with each other.

Yields from most wells in the area, placed either in glacial deposits or in bedrock, are less than ten gallons per minute. Ground water development is primarily for domestic and farm use. Municipal and industrial water is principally obtained from surface water bodies.

Ground water levels at the site were measured from four observation wells installed during the site exploration program. Hydrographs displaying water level elevations in the four observation wells, with respect to time, are shown in Figure 14. The initial slopes of the hydrographs indicate the time required for water levels in the observation wells to reach a hydrostatic level.

The water level of Observation Well 181, set at Elevation 449.8 near the highly fractured shale bedrock, stabilized 24 hours after installation; whereas, water levels of Observation Wells 7 and 24, set in glaciolacustrine silts at Elevations 450.5 and 452.3 respectively, required several months to stabilize, indicating they are essentially impermeable. The water level of Observation Well 40, placed in a glaciolacustrine silty clay with some sand and gravel, at Elevation 509.1, stabilized in three weeks, also indicating very low permeability.

Ground water contours of the probable water surface beneath the site are shown in Figure 15. Water level data spanning several years, obtained from the Michigan State Geological Survey, was used in constructing the ground water contours.

This data was used in conjunction with water level readings obtained in June 1974 from observation wells on the site.

Elevation of the ground water varies by about ten feet in the site area, generally increasing toward the St. Clair River. Water movement beneath the site appears to be westward away from the St. Clair River which is probably a recharge area. Approximate ground water levels are also shown on the subsurface profiles (Figure 9, A through N).

Depth to ground water on the site varies from 5 to 15 feet. Seepage of ground water into pits excavated below the zone of water saturation will probably be slow due to the very low permeability of the silty clays and silts that underlie the site. Pits excavated to a depth of 30 to 40 feet for the purpose of fly ash disposal were observed to contain no water from ground water seepage when left open for several days. The low permeability of the glaciolacustrine deposits is also indicated by the slow response of water levels in observation wells placed in either silty clays or silts. In cases where local sand or gravel lenses are encountered during excavations, ground water seepage may be substantial. However, a sump pumping system should be sufficient to control ground water seepage from sand and gravel lenses, since these are generally small in size and cannot store

much water. When predrilling for piles, water losses may be experienced when drilling through the basal glaciofluvial sand layer.

According to a southeastern Michigan water resources study (Ref 6), ground water from the glacial deposits is of the sodium bicarbonate type. In general, sodium and chloride concentration increase with depth. Water hardness ranges in concentration from 68.4 to 342.0 parts per million calcium carbonate, and iron ranges in concentration from 0.5 to 1.0 parts per million. Water from wells in bedrock varies in chemical composition, usually containing large amounts of calcium, bicarbonate, sulfate, and sodium chloride.

Knutilla's report (Ref 6) also indicates small to moderate supplies of fresh water are available from the highly fractured shale zone, but nearly all water is too highly mineralized for most uses. In general, mineralization of water increases with depth, whether in glacial deposits or bedrock.

4.1.4 Effects of Man's Activities

4.1.4.1 Presence of Oil and Gas

There are no active producing oil or gas fields in the immediate site area. Ten exploratory wells have been drilled on the site to an average depth of 2,500 feet. All wells were nonproductive except for two oil and gas producing wells located in the northwest corner of the site. These wells, producing from Niagaran reef formations, were abandoned in 1970.

Several oil and gas fields associated with reef structures have been developed in St. Clair County. The size of these fields averages 570 acres and oil production rates in 1971 were about 25 gallons per acre per day. All oil and gas fields surrounding the site appear to be fully developed and no further expansion is expected. Present oil and gas extraction are not expected to present problems to the plant structures. Figure 12 shows the locations of oil and gas wells on the site and in the site vicinity.

Isolated pockets of trapped gas occur in the overburden underlying the site. Gas was encountered in seven exploration borings (Table 1). No odor was detected in any

of these borings, and in all cases, the gas dissipated after 48 hours. Safety measures for determining the existence of and handling the gas should, however, be included in all earthwork and foundation contracts. No unusual design or construction problems due to the presence of gas are expected.

4.1.4.2 Salt Solution Mining

Thick salt deposits occur in two geologic horizons in Michigan: the Devonian Detroit River group and the Silurian Salina group. Salt beds in the Detroit River group are restricted to the northern half of the Lower Peninsula and do not underlie the site area. However, salt beds in the Salina group have a large areal extent covering the central three-fourths of the Lower Peninsula and occur beneath the site.

Salt solution mining from the Salina group by the Diamond Crystal Salt Company, located approximately one mile north of the site boundary, has been in progress for a number of years. The Salina group underlying the site contains five salt units interbedded with dolomitic shale, limestone, and anhydrite. The aggregate thickness of the salt is about 750 feet with the uppermost and lowermost units occurring,

respectively, at depths of approximately 1,400 and 2,500 feet below the site.

The potential for surface subsidence due to the collapse of solution cavities was evaluated from criteria used by the U.S. Bureau of Mines (Ref 7). A potential area of subsidence can be obtained by drawing a cone with sides at a 45° angle upward from the cavity. Surface subsidence due to that cavity will be within the area encircled by the cone's intersection with the ground surface.

A cavity at a depth of 2,500 feet will have a potential area of surface subsidence extending outward 2,500 feet from the cavity's edge. At the present location of the Diamond Crystal Salt Company's operations, surface subsidence due to a salt cavity at a depth of 2,500 feet is not expected within the site. It should be emphasized that further solution mining should not be permitted to develop cavities closer than 2,500 feet (horizontally) from any plant structures.

4.2 SUBSURFACE SOIL CONDITIONS

4.2.1. General

The soil profile at this site may be divided into three major strata. These divisions were based upon field observations combined with results of all laboratory testing. These strata have been designated as the upper, middle, and lower strata and refer to depths of 0 to 20 feet, 20 to 50 feet, and below 50 feet, respectively. Except for the dock, secondary coal storage area, and fly ash disposal areas, the entire site has a surface elevation of about Elevation 586, generally ranging from Elevation 585 to Elevation 590. The dock area is lower at Elevation 580 to Elevation 582, while the secondary coal storage area and fly ash disposal area are higher at approximately Elevation 590 and 600 respectively. Therefore, the depths of the different strata are approximate and are expected to vary within 5 to 15 feet throughout the entire project site. For any particular location, the boring logs should be consulted to associate the soil properties with a particular stratum. Generalized ground surface contours are shown in Figure 16.

Selected subsurface profiles throughout the entire site are shown in Figure 9, A through N. The distribution of

standard penetration blowcount with depth for various areas is shown in Figure 17.

4.2.2 Upper Stratum (0-20 Feet)

The upper stratum consists primarily of mottled brown and gray, stiff to very stiff, clays (Classification CL-CH) with traces of fine sand and pebbles. Standard penetration blowcounts increased from approximately 5 to 15 at the ground surface to a range of from 10 to 40 at a depth of 10 feet (Figure 17). Below this depth, the blowcounts decreased to a range of from 3 to 12 at a depth of approximately 20 feet. Below 20 feet, there is an observable change in the color and consistency of the clay; therefore, a depth of 20 feet is considered the bottom of the upper stratum at this site.

Laboratory consolidation testing has shown this stratum to be overconsolidated. This preconsolidation was also confirmed by the results of consolidated-undrained triaxial testing, the empirical Skempton relationship as used to determine preconsolidation pressure based on the undrained shear strength of the soil and the liquid limit (Ref 8), and also a comparison of the natural moisture content with the

Atterberg limits. It is believed that this stratum was preconsolidated by desiccation based on undrained shear strength behavior and other geologic evidence. The estimated preconsolidation pressure ranges between 4,000 to 9,000 psf. This corresponds to an overconsolidation ratio between 4 and 8.

4.2.3 Middle Stratum (20 to 50 Feet)

Below the upper stratum, there is a very soft to soft gray silty clay (Classification CL) which extends from approximately 20 feet below the ground surface to 50 feet below the ground surface. However, this stratum was encountered as close as 11 feet from the ground surface in the dock area.

Standard penetration blowcounts in this stratum ranged between fairly close limits. In all areas except the docking facility, blowcounts ranged from 2 to 7 blows per foot. Generally, the higher blowcounts were noted at the top and bottom of the stratum and decreased in the center. At the docking facility, the average blowcounts remained constant at about 2 blows per foot throughout the entire depth, and the higher blowcounts remained constant at an

average of 15 blows per foot. Although blowcounts at the docking facility were somewhat lower than other locations, laboratory engineering properties were not significantly different.

Consolidation tests and other empirical evaluations show this stratum to be slightly overconsolidated, with preconsolidation pressures ranging between 3,500 to 4,500 psf. This corresponds to an overconsolidation ratio between 1.3 and 2.0.

4.2.4 Lower Stratum (Below 50 Feet)

This stratum consists primarily of a firm gray plastic silty clay Classification (CL). However, some fine sand seams and silty clays with an appreciable amount of sand (as much as 40%) were encountered at various depths as shown in the subsurface profiles (Figure 9, A through N). Significant sand deposits were also found beneath the main plant area as noted in Section 4.1.2.

Blowcounts in this stratum varied depending on the amount of sand present. Typical standard penetration blowcounts

ranged from 2 to 7 blows per foot at a depth of 50 feet, to 10 to 25 blows per foot at a depth of 70 feet. Below the 70 foot depth, the standard penetration blowcount in the clay soils increased to an average of approximately 20 blows per foot at a depth of 125 feet (range of 5 to 40). Below this depth, the blowcounts in all areas increased until bedrock was encountered at depths of 125 to 145 feet. Within this depth range, clays with high sand content, sand deposits, hardpan, or combinations were encountered above the bedrock. Standard penetration blowcounts in the sandy zones above the bedrock are quite variable, although the average was found to be 40 to 50 blows per foot.

Except where a significant amount of sand was present, this stratum can be subdivided into three layers based on the degree of overconsolidation. These layers are from 50 to 70 feet (transition zone between upper and middle strata), 70 to 90 feet and below 90 feet, respectively.

4.2.4.1 Layer From 50 to 70 Feet (Transition Zone)

The first of these layers is designated as the transition zone and ranges from 50 to 70 feet deep. According to Skempton's statistical relationship and the natural moisture content and plasticity ranges, the soils within this layer

are slightly overconsolidated. The Skempton empirical procedure was used to evaluate the preconsolidation pressure because of the lack of a sufficient number of consolidation tests for this layer. The estimated preconsolidation pressure for this layer ranges between 4,000 to 8,000 psf. This corresponds to an overconsolidation ratio between 1.0 and 1.6.

4.2.4.2 Layer From 70 to 90 Feet

Based on consolidation tests and the same Skempton relationship, the soils within the depth range of 70 to 90 feet are considered slightly overconsolidated but to a greater degree than the transition zone. Apparently, the normal geological process of deposition of the clay was interrupted at this depth. Since the soil appears to be virtually the same type as that below it, this increased overconsolidation must be due to either additional deposition above 70 feet and then erosion to the 70-foot depth, or desiccation as was noted in the upper layer, followed by deposition to its present elevation. The undrained shear strengths have the general tendency to decrease very slightly with depth below 70 feet, thus the apparent overconsolidation is likely due to desiccation. The estimated preconsolidation pressure for this layer

ranges between 6,000 and 9,000 psf. This corresponds to an overconsolidation ratio between 1.0 and 2.4.

4.2.4.3 Layer Below 90 Feet

The soil properties below 90 feet are very similar to those immediately above, except for the degree of overconsolidation and undrained shear strength.

Consolidation test results and evaluation of the moisture content versus Atterberg limits show these soils to be very slightly overconsolidated to normally consolidated. The estimated preconsolidation pressure for this strata ranges between 6,000 and 9,000 psf. This corresponds to an overconsolidation ratio between 1.0 and 1.2.

5.0 LABORATORY SOIL TESTING

5.1 INTRODUCTION

The laboratory testing program consisted of the classification and engineering properties tests listed below and further described in this Section. The testing program was developed by Bechtel and conducted by Goldberg-Zoino and Associates and U. W. Stoll and Associates under the direction of Bechtel.

- a) Visual and Laboratory Classification
- b) Moisture Content and Dry Unit Weight
- c) Atterberg Limits
- d) Specific Gravity
- e) Mechanical Analysis
- f) Unconfined Compression Test (Qu)
- g) Laboratory Vane Shear Test
- h) Unconsolidated-Undrained Triaxial Compression Test (UU)
- i) Consolidated-Undrained Triaxial Compression Test With Pore Pressure Measurement (CU)
- j) Consolidation Test
- k) Permeability Test
- l) Compaction Test

The majority of testing was carried out by Goldberg-Zoino and Associates of Newton Upper Falls, Massachusetts, from January 1974 through January 1975. Additional tests were made by U. W. Stoll & Associates of Ann Arbor, Michigan, during the summer of 1975. This was to provide more detailed information for the coal reclaim hopper south of Transfer House 5 (Figure 2).

The test data are presented in Appendix C of Volume 2 in the form of tables and figures. Selected properties such as dry density, moisture content, Atterberg limits, and soil cohesion from unconfined compression, unconsolidated-undrained triaxial testing and vane shear tests have also been included on the boring logs presented in Appendix B. Interpretation of test data and development of soil properties for design are presented in Section 6.

5.2 CLASSIFICATION TESTS

Visual classification was in accordance with ASTM D 2488, and laboratory classification was in accordance with ASTM D 2487.

5.2.1 Moisture Content and Dry Unit Weight

Moisture content and dry unit weight were determined for all undisturbed soil samples selected for any type of testing, along with the moisture contents for other selected split spoon samples. Determination of moisture content was made in accordance with ASTM D 2216 and the unit weight was determined by direct measurement.

5.2.2 Atterberg Limits

Atterberg limits determinations were made in accordance with ASTM D 423 (liquid limit) and ASTM D 424 (plastic limit) on all samples selected for unconfined and triaxial shear testing, consolidation testing, and on other selected plastic soils.

5.2.3 Specific Gravity

Specific gravity tests were made on all samples subjected to consolidation testing, as well as on other selected samples, in accordance with ASTM D 854.

5.2.4 Mechanical Analysis

Mechanical and hydrometer analysis determinations were made in accordance with ASTM D 422 on selected samples.

5.3 ENGINEERING PROPERTIES TESTS

5.3.1 Unconfined Compression Tests

Unconfined compression tests were performed on representative samples of all strata to evaluate the in situ shear strength. The tests were also performed on remolded samples to evaluate the soil sensitivity and the available shear strength under remolded conditions. All tests were performed in accordance with ASTM D 2166. Stress versus strain curves have also been presented in Appendix C. These allowed an evaluation of the shear strength at different strain levels and also the initial tangent modulus. Dry density, moisture content, and Atterberg limits are also reported for each test. Results for undisturbed samples are summarized in Table 2 while the results for compacted samples are summarized in Table 3.

5.3.2 Laboratory Vane Shear Tests

Vane shear tests were performed on selected soil samples from the dock area to evaluate both the undisturbed and remolded shear strengths. This was done primarily to determine the degree of sensitivity of the soil and also to compare the results with those of other undrained shear strengths. This data is summarized in Table 4.

5.3.3 Unconsolidated-Undrained Triaxial Compression Tests (UU)

Unconsolidated-undrained triaxial compression tests were made on selected undisturbed samples to compare with the results obtained from the unconfined compression testing. This test is also considered appropriate for cohesive samples which contain appreciable amounts of silt or sand size particles. Procedures utilized were in accordance with ASTM D 2850.

All unconsolidated-undrained triaxial tests were performed at confining pressures approximately equal to the effective overburden pressure at the sample depth. The stress-strain curves, moisture contents, and dry densities are also given

on the laboratory test result sheets in Appendix C. The results are summarized in Table 5.

5.3.4 Consolidated-Undrained Triaxial Compression Tests
with Pore Pressure Measurements ($\bar{C}U$)

Consolidated-undrained triaxial compression tests with pore pressure measurements were made on undisturbed samples from all strata and on selected remolded samples using the Harvard Minature Compaction Method. All samples were saturated by the back pressure method. A minimum of three separate samples at the same approximate depth were then consolidated to confining pressures approximately equal to 0.5, 1.0, and 2.0 times the effective overburden pressure, respectively, before testing. Confining pressures, moisture contents, dry densities, etc. are shown on the test data sheets. Effective and total strength envelopes were obtained for each series tested. Plots of pore water pressure, deviator stress, principal stress ratio, and Skempton's A parameter versus strain are given in Appendix C. All results are summarized in Table 6.

5.3.5 Consolidation Tests

Consolidation tests on selected soil samples were made by loading test specimens up to applied pressures as high as 24 ksf in accordance with ASTM D 2435. A modification of ASTM D 2435 to provide a rebound-recompression curve near the overburden pressure (Burmister Loop) was also used on selected samples (Ref 9). This modification consisted of loading the test specimens to the approximate in-situ overburden pressure, or slightly above, and then reducing the load to either 2 or 4 ksf. Samples were then reloaded to the maximum pressure and rebounded to zero load. The consolidation bowl was filled with water when the pressure reached the approximate effective confining pressure at the sample depth. Tests on compacted samples were also made. Results of the consolidation tests and a summary of the coefficient of consolidation by both the square root and logarithm of time fitting method are included in Appendix C. The results of undisturbed and compacted samples are summarized in Tables 7 and 8, respectively.

5.3.6 Permeability Tests

Laboratory permeability tests were performed on representative clay specimens. Specimens were saturated by the back pressure method and tested under a confining pressure equal to the effective overburden pressure. Permeability was determined by using the constant head permeability test as adapted to triaxial equipment. All permeability results are summarized in Table 9.

5.3.7 Compaction Tests

Compaction tests were made in accordance with ASTM D 1557 on selected samples representative of the upper soils that could be excavated and used as a fill material. The curves of dry unit weight versus moisture content are presented, along with the Zero air voids curve in Appendix C.

6.0 SOIL PROPERTIES FOR DESIGN

6.1 INTRODUCTION

In this section, the results of laboratory tests are discussed along with the ranges and recommended design values of soil properties. The generalized design values are believed to be conservative for the entire site. Higher values may be justified based on a localized evaluation of subsurface conditions and on the nature of the engineering problem under consideration. The recommended design properties of the site soils are compiled in Table 10.

6.2 INTERPRETATION OF LABORATORY TEST DATA

6.2.1 Natural Moisture Content and Dry Unit Weight

The natural moisture content and dry unit weights for the entire site have been plotted in Figure 18. In addition, for each sample, the corresponding total unit weight has also been calculated and presented. Although the figure for moisture content shows a fairly narrow range at all depths, there is considerably more scatter in the measured dry unit

weight, thus producing a moderate scatter for the total unit weight. The design value for total unit weight versus depth has been based upon the predominant density at each depth with appropriate consideration for the scatter. Generally, as shown in Figure 18, a constant value of total unit weight can be used for each major stratum. Following are the ranges and recommended design values for each major stratum:

Ranges of Natural Properties				
<u>Depth (Ft)</u>	<u>Dry Density (PCF)</u>	<u>Moisture Content (%)</u>	<u>Total Density (PCF)</u>	<u>Design Total Density (PCF)</u>
0-20	95-105	22-34	115-133	125
20-50	80-90	30-45	110-125	115
50-110	95-105	15-30	120-130	125
110+	80-100	20-40	110-124	120

The scatter in dry unit weights below a depth of 110 feet as shown in Figure 18, is likely due to the presence of a slightly higher percentage of sand in some of the samples at this depth.

6.2.2 Atterberg Limits

Atterberg limits results are presented in Figures 19 and 20. Figure 19 contains three plasticity charts showing values of plasticity index (PI) and the liquid limit (LL) for the upper, middle, and lower strata. As shown in this figure, the upper stratum is the most plastic and the lower stratum the least plastic. This is attributed to the higher silt and sand content of the lower stratum. Ranges of liquid limit, plastic limit (PL), and plasticity index were derived for each of the three strata.

<u>Depth</u>	<u>LL</u>	<u>PL</u>	<u>PI</u>
0-20	39-63	17-26	18-39
20-50	35-55	16-25	15-32
50+	20-55	12-25	8-31

Figure 20 shows the plasticity ranges and the corresponding moisture content versus depth for the main plant area, the main coal storage area, and the dock area. The figure shows that the plasticity characteristics of these three areas are similar.

6.2.3 Mechanical Analysis

This site is predominantly a clay site with the exception of the 60 foot thick sand deposit above rock in the vicinity of the main plant. Localized sand and silt lenses of nominal thickness were also found at variable locations and elevations throughout the site.

Grain size distribution curves for the upper, middle, and lower strata are shown on Figures 21 and 22. Figure 22 further subdivides the grain size distribution curves of the lower stratum for five major areas of the site.

Nearly uniform conditions were encountered in the upper stratum with very little evidence of sand. This is shown in Figure 21 by the very close grouping of the grain size distribution curves within the clay size range.

Below 20 feet, a significantly greater percentage of sand size particles is apparent from Figures 21 and 22. Figures 21 and 22 show that in general, the cohesive soils within the middle and lower strata do not contain more than about 40 percent sand, and most have no more than 20 to 30 percent sand.

The grain size results for the site are presented in Figure 23 in a different manner. This figure is a presentation of the mean grain diameter D_{50} versus depth. It shows that, above the 90 to 100 foot depth, the majority of the data points fall within the clay and silt range while, below the 90 to 100 foot depth, the majority of the data points fall within the silt and sand ranges.

6.2.4. Activity of Clay

The activity of a clay is determined by plotting the plasticity index versus the percent of clay size particles less than two microns on an activity chart as shown in Figure 24. The figure shows that the activity values of the different samples represented are generally similar, making it possible to fit a single straight line through all the data. This line has a slope of 0.4 indicating the activity. The values generally ranged between 0.3 and 0.5. These activity values put the clays at the site in the inactive category according to Skempton (Ref 10).

6.2.5 Undrained Shear Strength

The results of all unconfined and unconsolidated-undrained compression tests along with all of the laboratory vane shear tests are combined in Figure 25. This figure shows the results of each type of test with a different symbol. Other than for the upper stratum where the unconsolidated-undrained shear strengths were somewhat higher, all three types of tests gave comparable results. The shear strength was also evaluated for each major area separately (dock, coal hopper, main plant); however, it was found that the generalized interpretation shown by the dashed line in Figure 25 is conservative and representative for all areas.

The shear strength results from previous borings in the St. Clair Power Plant area are presented in Figure 26. The interpretations of the two sets of data shown in Figures 25 and 26 are superimposed in Figure 27 for comparison. This figure shows that the strength values obtained from the two separate investigations are in good agreement.

In addition, the empirical Skempton relationship:

$$S_u/P = 0.1 + 0.004 PI \quad (1)$$

has been used to calculate the undrained shear strength (S_u) for known values of plasticity index under two overburden pressure (\bar{P}) conditions. One assumption is that \bar{P} is equal to the effective overburden pressure (Figure 28a) and the other assumes that \bar{P} is equal to the overconsolidation pressure determined by Casagrande's Method (Figure 28b). These assumptions give the anticipated upper and lower boundaries of undrained shear strength as determined by this relationship. The range of plasticity index for the soils tested during this investigation (Section 6.2.2) fall within the range of applicability of Equation 1 as shown in Reference 8.

The design recommendations presented below were based on the results shown in Figure 25 with consideration of the results of previous investigations (Figure 26) and the empirical undrained shear strength values obtained from the Skempton relationship (Figure 28).

<u>Stratum</u>	<u>Depth Below Ground Surface (Feet)</u>	<u>Peak Undrained Shear Strength (psf)</u>	
		<u>Effective Range</u>	<u>Design Value</u>
Upper	0-20	1,100-3,000	550
Middle	20-50	350-1,500	550
Lower	50-90	500-3,000	1,000
	90+	500-1,500	850

The basis for the selection of the design undrained shear strength for the upper stratum is discussed below.

6.2.5.1 Upper Stratum

Based upon the laboratory test results from this investigation, the undrained shear strengths for the upper stratum were found to range between 1,100 and 3,000 psf. The most predominant value of undrained shear strength was approximately 2,000 psf. These undrained shear strengths generally tend to decrease with depth which is indicative of a clay preconsolidated by dessication.

However, it should be emphasized that for preconsolidated clays having overconsolidation ratios of four to eight as in this case, the peak undrained shear strength often cannot be depended upon. The laboratory peak strength for soils of this type will give higher undrained shear strength than

that which will actually develop in the field under long term conditions. This is because high negative pore pressures develop during shearing of the soil in the laboratory (Ref 11) and these are not expected to develop to the same extent or remain for any long period of time in the field. In addition, as the soil dries out (desiccates), the soil contracts and shrinkage cracks form within the desiccated layer. This allows failure to occur on pre-formed failure planes and the full undrained strength of the soil is not developed. For this situation, the available long term strength is closer to the residual strength (Ref 12).

In evaluating the shear strength to be used for the upper stratum, the typical shape of the stress-strain curves during failure of the sample was also considered. These curves are shown for each sample on pages C-271 through C-341 of Appendix C in Volume 2. The curves show a "brittle" soil which reaches its maximum strength at relatively low strain (2-5%), at which point the strength drops off fairly rapidly. This stratum will reach its maximum strength first with respect to the lower stratum, if subjected to the same strain.

It should be noted however that the reduction in strength with increasing strain was noted primarily in the unconfined compression tests which represented the majority of available data. This strength reduction is partially caused by the lack of sample confinement inherent in the test.

Considering all of the above factors, a design shear strength of 550 psf is recommended for the upper stratum. This value is approximately one half the lower bound strength predicted from the laboratory tests. Values up to 1100 psf may be justified in some situations.

Comparing the above laboratory test results with the empirical shear strength values obtained by the Skempton procedure, the average undrained shear strength for the stratum would range between 250 psf, for a normally consolidated soil (Figure 28a), to 1,000 psf for an overconsolidated soil (Figure 28b). It should be noted, however, that the values of shear strength are influenced by the effective overburden or preconsolidation pressure substituted into the Skempton relationship. In reality, the shear strength for the upper stratum will be higher than that indicated in Figure 28a for a normally consolidated soil. This is primarily because of the influence of the

shallow depth and the preconsolidated nature of this stratum. Since this stratum is overconsolidated, the empirical shear strength value of 1,000 psf, as shown in Figure 28b, should be closer to the actual shear strength.

Although higher shear strengths were obtained from undrained shear strength testing, the higher values cannot be recommended because of the potential pre-formed failure planes and also the relatively high negative pore pressures that develop in testing but do not exist to the same degree in the field. Both of these tend to decrease the measured shear strength, although the amount of decrease cannot be adequately determined. Thus, a value of 550 psf is recommended primarily based upon the residual shear strengths obtained from unconsolidated-undrained shear strength testing and the results of triaxial testing.

6.2.5.2 Middle Stratum

The middle stratum has been found to be the weakest stratum at this site. Undrained shear strengths based on laboratory test results range from 300 to 1,000 psf with the most predominant value being 550 psf. Unlike the upper stratum, the stress-strain curves for this stratum typically peak at

low strains (about 2%) with only a slight reduction in strength at higher strains. As shown in Figure 25, the shear strength from test results can be taken as approximately constant with depth at 550 psf over the range of 20 to 50 feet. This value is recommended for design. The strength of 550 psf was found to be within the range obtained from the Skempton's relationship utilizing both the effective overburden pressure and preconsolidation pressure (Figure 28a and b, respectively).

If normally consolidated conditions are assumed as shown in Figure 28a, the resulting shear strength is very nearly equal to that obtained by laboratory testing. The figure shows a gradual increase in shear strength with depth ranging from about 400 psf at a depth of 20 feet to about 650 psf at a depth of 50 feet. This increase is imposed by the nature of Skempton's relationship and should be expected for normally consolidated clays if perfect samples are obtained. The laboratory results do not show this trend, and this is an indication of sample disturbance. A slightly higher shear strength is obtained when the preconsolidation pressures are used as shown in Figure 28b: the average shear strength decreases from 900 psf at a depth of 20 feet to 800 psf at a depth of 50 feet. This reduction in strength

with depth is caused by the reduction in preconsolidation pressure determined from consolidation testing.

6.2.5.3 Lower Stratum

The lower stratum can be taken as beginning at a depth of approximately 50 feet and extending to bedrock at depths ranging from approximately 125 to 145 feet. This stratum may be further subdivided into two layers as far as the undrained shear strength is concerned.

6.2.5.3.1 Layer From 50-90 Feet

As shown in Figure 25, distinctly higher shear strengths were obtained from depths of 50 to 90 feet. The soils in this layer are considered to be moderately overconsolidated. Comparing the natural moisture content and dry unit weight in this layer with the layer below, the natural moisture content did not decrease significantly with increasing depth nor did the dry unit weight increase significantly with increasing depth. Thus, it is possible that this layer was also preconsolidated by desiccation, although the trend in

shear strength variation with depth does not provide enough evidence to conclude this.

A fairly wide range of laboratory shear strengths was obtained as shown in Figure 25. These values ranged from about 500 to 3,000 psf with approximately two-thirds of the data ranging between 500 and 1,500 psf and the other third between 1,500 and 3,000 psf. The most predominant value between 500 and 1,500 psf was 1,000 psf. As shown in Figure 28, the estimated shear strength at a depth of 50 feet, based on the Skempton statistical procedure, was found to be either 650 or 850 psf, depending on whether normally consolidated or overconsolidated conditions are assumed. Both procedures give a shear strength of approximately 1,000 psf at a depth of 90 feet.

Typical stress-strain curves for soils between 50 and 90 feet either remain constant with strain near the peak stress or drop somewhat as can be seen on pages C-271 thru C-341 of Appendix C in Volume 2. However the drop in stress occurred at a higher strain in the range of 10-12%.

Considering the higher strain at which the peak soil strength occurs and not discounting completely the lower

shear strengths as predicted by the Skempton procedure, the shear strength of 1,000 psf is recommended for this layer.

6.2.5.3.2 Soils Below 90 Feet

Indications are this layer is normally to very slightly overconsolidated. Based upon the laboratory test results, the shear strength in this layer ranges between 500 and 1,500 psf with an average of approximately 850 psf. The decrease in undrained shear strength, as compared to the layer above, was also noted in the laboratory test results obtained from the previous investigations. Figure 26 shows values of shear strength between 200 and 1,000 psf with an average of 600 psf.

Comparison of the strength predicted from Skempton's equation (Figure 28) and the strength data in Figure 25 shows that the upper bound of the laboratory strength (1,500 psf) is close to the strength predicted by the Skempton equation. However, it should be noted that in this case, the Skempton procedure is also influenced by the greater depth (the actual value of the effective vertical pressure), and it is possible that the actual shear strength may be lower than predicted by this method.

The actual shear strength reduction associated with the soil below 90 feet may be due to several causes, the most plausible of which is sample disturbance. This was borne out by running both undisturbed and remolded unconfined compression tests (at the same moisture content and dry density) on the same sample, see Tables 2 and 3. The ratio between these two tests (undisturbed strength divided by remolded shear strength) is called sensitivity. These tables show that the sensitivity of the site soils was generally between 1.0 and 1.5. This is another indication that, but not necessarily a conclusion that, the samples have been disturbed.

One additional consideration in explaining the reduced strengths at great depths is the amount of sand present (Figures 21, 22, and 23). This could cause a reduction of the laboratory strength in unconfined compression tests.

Since the standard penetration blowcounts do not decrease within this depth (Figure 17), and the Skempton empirical relationship shows a high strength, the average strength of 850 psf obtained from laboratory tests is considered conservative and is recommended for the soils below 90 feet.

6.2.6 Shear Strength From CU Tests

The long term (drained) shear strength has been determined by consolidated-undrained triaxial tests with pore pressure measurements. In addition to the Mohr-Coulomb envelopes for total and effective stresses, the deviator stress, effective stress ratio, change in pore pressure, and Skempton's A parameter have also been plotted versus strain and are included in Appendix C of Volume 2. The failure criteria presented was based on the peak deviator stress. If a maximum stress ratio failure criteria is desired, it can be readily obtained.

In order to evaluate the total and effective stress parameters, the stress point or "p-q" diagram as suggested by Lambe and Whitman (Ref 13) has been used. These diagrams are shown in Figures 29 and 30 for total and effective stress parameters, respectively. These figures show that the "p-q" diagram for effective and total stress can be idealized by two straight lines intersecting at a pressure corresponding to a depth in the range of 55 to 62 feet. This depth also corresponds to the division between the middle and lower stratum. The "p-q" diagrams are used to calculate the effective and total stress parameters required

to determine shear strength from the Mohr-Coulomb relationships (Ref 13).

The Mohr-Coulomb relationship for effective stresses is given by:

$$\tau = c' + \sigma' \tan \phi' \quad (2)$$

Where τ = drained shear strength

σ' = effective normal stress on failure plane at failure

c' = cohesion intercept for effective stresses

ϕ' = angle of internal friction for effective stresses,

and the Mohr-Coulomb relationship for total stresses is given by:

$$S = c + \sigma \tan \phi \quad (3)$$

where S = shear strength

σ = total normal stress on failure plane at failure

c = cohesion intercept for total stresses

ϕ = angle of internal friction for total stresses.

Recommended values of effective and total stress parameters for each stratum are given below:

<u>Depth (Ft)</u>	<u>Total Stress Basis</u>		<u>Effective Stress Basis</u>	
	ϕ	<u>c (PSF)</u>	ϕ'	<u>c' (PSF)</u>
0-20	13°	450	28°	0
20-50	13°	450	28°	0
50+	10°	700	22°	250

6.2.7 Tangent Modulus of Elasticity

The initial modulus of elasticity has been plotted versus depth on Figure 31 for all of the undrained shear strength tests. Although there is some scatter, a reasonable design value can be determined for each of the three strata. These values are given below and are further discussed in this section.

<u>Stratum</u>	<u>Depth (ft)</u>	<u>Undrained Tangent Modulus E (ksf)</u>		
		<u>Effective Range</u>	<u>Average</u>	<u>Design Values</u>
Upper	0-20	100-200	175	700
Middle	20-50	25-120	65	330
Lower	50+	25-240	100	550

It has been found that for settlement calculations the values obtained from undrained shear strength tests should be increased by a factor of four to five to give results that agree with measured settlements (Ref 13). The lower measured test values can be attributed to sample disturbance. Bjerrum (Ref 14) has suggested that the modulus can be obtained by multiplying the undrained shear strength by a factor of 400 to 600. However, for this site, the ratio E/S_u has been found to be approximately 100 for all of the soils tested, except the middle stratum which showed a slightly higher ratio of approximately 140. Therefore, the values of E/S_u obtained in this investigation are apparently lower by a factor of four to six than what would be generally expected. Both the modulus of elasticity and the undrained shear strength are apparently lower, with the greater reduction in the modulus of elasticity.

Therefore, an increase in the modulus of elasticity from test results by a factor of as high as four to five is justified in the average modulus of elasticity values as determined from the undrained shear strength tests. Based on this criteria, and the corresponding criteria of 400 to 600 times the undrained shear strength, initial static modulus of elasticity values of 700, 330, and 550 ksf are

recommended for the upper, middle, and lower strata, respectively.

6.2.8 Consolidation

6.2.8.1 Preconsolidation Pressure

Figure 32 shows the variation of preconsolidation pressure with depth as determined by Casagrande's Procedure. Samples believed to be relatively disturbed based on the shape of the consolidation curve have been designated with a different symbol in Figure 32. Also included in this figure is a plot of moisture content with respect to Atterberg limits versus depth for all of the consolidation tests to assist in estimating the degree of overconsolidation. A natural moisture content near the plastic limit indicates an overconsolidated soil, whereas a natural moisture content near the liquid limit indicates a normally consolidated soil. These data are shown on the left side of Figure 32 for each of the consolidation test results presented. This figure shows the subsurface soils at this site are preconsolidated to some degree, for their entire depth.

To help determine a design preconsolidation pressure, Skempton's procedure has also been used to estimate the preconsolidation pressure from the plasticity index and the unconfined and unconsolidated-undrained compression tests. This interpretation is shown in Figure 33.

As shown in Figure 32, almost all of the soils at this site, with the exception of the upper stratum soils (0-20 feet) and soils from 50 to 90 feet, can be considered normally to slightly overconsolidated for design purposes. This is because of the relatively slight overconsolidation shown by consolidation tests.

The soils from 0 to 20 feet (upper stratum) have been preconsolidated by desiccation. This judgement is based primarily on the general decrease in shear strength with depth as shown in Figure 25 as opposed to soils preconsolidated by either glaciation or preloading which will have shear strengths increasing with depth.

The design preconsolidation pressure for the upper stratum has been determined by drawing the precompression line along the lower bound of preconsolidation pressure as determined by consolidation test results. This is nearly parallel to

and slightly lower than the preconsolidation line as determined by the Skempton procedure (Figure 33).

Preconsolidated soils were also noted between 50 and 90 feet based on consolidation tests and the Skempton equation (Figures 32 and 33). This is also the depth range in which higher undrained shear strengths were obtained from laboratory tests (Figure 25). Although it cannot be said conclusively, it appears that the soil from 50 to 90 feet was also preconsolidated by desiccation as with the upper stratum rather than by glaciation. Since the soils below 90 feet appear to be only slightly overconsolidated at the most, desiccation appears to be the most plausible explanation for the preconsolidation.

Considering the scatter in the preconsolidation pressure based on Casagrande's Method and the predicted preconsolidation pressure based on Skempton's relationship, the recommended design curve for preconsolidation pressure is as shown in Figure 33.

6.2.8.2 Settlement Parameters

The compression index (C_c), swelling index (C_r), initial void ratio (e_o) and the settlement parameter ($C_c/1+e_o$) all versus depth are shown in Figures 34, 35, 36, and 37. The range of values is small enough that a constant value can be used throughout each major stratum, and the design curves shown are drawn to reflect this. Presented below are the ranges and recommended design values for the various parameters.

<u>Depth (ft)</u>	<u>C_c Range</u>	<u>C_r Range</u>	<u>e_o Range</u>
0-20	0.14-0.16	0.05-0.07	0.65-0.80
20-50	0.33-0.45	0.09-0.10	0.72-1.10
50+	0.18-0.41	0.05-0.08	0.60-1.00

<u>Depth (ft)</u>	<u>$C_c/1+e_o$</u>		<u>$C_r/1+e_o$</u>
	<u>Range</u>	<u>Design</u>	<u>Design</u>
0.20	0.10-0.15	0.13	0.04
20-50	0.15-0.24	0.20	0.04
50+	0.11-0.21	0.14	0.04

Values of the compression index (C_c) and the swelling index (C_r) are plotted versus liquid limit, for the soils tested, in Figure 38. The soils from the upper stratum are

identified with different symbols because of the overconsolidation of this stratum. The empirical relationship:

$$C_c = 0.009 (LL - 10) \quad (4)$$

and the plus or minus 30 percent upper and lower bounds suggested by Terzaghi and Peck (Ref 12) are superimposed in Figure 38. The compression index values (C_c) measured in this investigation compare favorably with the empirical relationship. The data for the upper stratum fall around the lower bound of this relationship, as should be expected because of the overconsolidation.

Similar results were obtained for the swelling index (C_r) values. Based on the data in Figure 38, the relationship between swelling index and liquid limit for the soils tested can be expressed by the equation:

$$C_r = 0.002 (LL - 2.5) . \quad (5)$$

Figure 38 also shows an upper and lower bound representing a variation of plus or minus 30 percent from the above relationship. It was found that these lines represent good upper and lower bounds for the data.

6.2.8.3 Coefficient of Consolidation

Figure 39 shows values of the coefficient of consolidation (C_v) versus pressure for the three major strata. The relationship between C_v and the logarithm of pressure is represented by a band and an average curve for each stratum as shown in the figure. These bands and average curves conform to the general relationship presented by Lambe (Ref 15). As shown in the figure, the effective range of the coefficient of consolidation is 0.05 to 0.25 square feet per day for all samples tested over the pressures involved. An overall average of 0.15 square feet per day is recommended for design.

6.2.9 Permeability

Constant head permeability tests were performed on samples of silty clay taken from depths ranging from 20 to 90 feet. All samples were saturated in a triaxial cell by back pressure and tested at a confining pressure approximately equal to the effective overburden pressure. The coefficient of permeability was found to range from 1.6×10^{-8} cm/sec to 2.6×10^{-8} cm/sec for void ratios between 0.4 and 0.9. Thus, for any engineering analysis, an average permeability

of 2×10^{-8} cm/sec may be used for the silty clays found at this site.

6.2.10 Compaction

The results of all laboratory compaction tests are shown in Figure 40. The tests were performed on samples from the upper stratum and the results grouped according to soil type. Since the soils below this depth are soft to very soft, only the upper stratum is expected to be used for fill material. The zero air void curves (100% saturation) were plotted assuming specific gravities of 2.70 and 2.75. The two diagrams on the left side of the figure (CL and CH soils) show results from samples taken northwest of the plant site near the intersection of King and Puttygut roads. This is within the proposed fly ash disposal area and is a potential borrow area for the remainder of the plant. The diagram on the right side of this figure (CL-CH soils) shows results from samples taken in the vicinity of the proposed main coal pile.

Since the most predominant natural moisture content for the upper stratum soils is about 26%, this indicates that on the order of 10% to 16% reduction in moisture content will be

necessary to compact these soils to the maximum dry density, and approximately 6% to 10% reduction will be necessary to obtain 95% of the maximum. Because of the relatively large amount of drying required, compaction of these soils will be difficult.

7.0 SUMMARY AND CONCLUSIONS

An extensive subsurface investigation program was conducted at the Belle River Project site. The investigation consisted of geologic studies, ground water measurements, soil/rock borings, and laboratory soil testing, along with an evaluation of previous investigations at the site. The subsurface investigation was directed at confirming the suitability of the site and providing generalized soil parameters and information for design of the various plant facilities.

The investigation showed that:

- a. Geologic and subsurface soil conditions at the site are suitable for the development of the site.
- b. Ground water information, based on four observation wells monitored for a period of one year, have been accumulated and presented.
- c. The soil parameters for design and construction evaluations have been developed in the report and are further summarized in the Tables. The

results are considered to be conservative and are applicable for the entire site. Soil boring logs showing the pertinent soil parameters are also presented in Appendix B.

Depending on the engineering problem under consideration, localized and more extensive evaluations or investigations may be required to expand upon the available information.

8.0 REFERENCES

1. R. J. Brigham, "Structural Geology of Southwestern Ontario and Southeastern Michigan," Ontario Department of Mines and Northern Affairs, Petroleum Resources Section, Paper 71-2, 1971.
2. S. T. Algermissen, Seismic Risk Studies in the United States (1969), National Oceanic and Atmospheric Administration, U.S. Department of Commerce, Washington, D. C.
3. J. A. Door, Jr. and D. F. Eschman, Geology of Michigan, The University of Michigan Press, Ann Arbor, 1971.
4. J. H. Fisher (chairman), Stratigraphic Cross-Sections, Michigan Basin (1969), Michigan Basin Geological Society.
5. G. D. Ells and B. L. Champion (compilers), Michigan's Oil and Gas Fields 1972, Annual Statistical Summary No. 18 (1973), Michigan Department of Natural Resources, Geological Survey Division.
6. R. L. Knutilla, Gazetteer of Hydrologic Data for the Belle River Basin, Southeastern Michigan, (1969), Southeastern Michigan Water Resources Study, Technical Paper No. 2, U. S. Geological Survey, Water Resources Division.
7. L. Panek, (Personal Communication), U. S. Bureau of Mines, Mining Research Center, Denver, Colorado.
8. A. W. Skempton, "Discussion: The Planning and Design of the New Hong Kong Airport," Proceedings of the Institution of Civil Engineers, Vol. 7, London, 1957, p. 305-307.
9. D. M. Burmister, "The Application of Controlled Test Methods in Consolidation Testing: Symposium on Consolidation Testing of Soils," ASTM Special Technical Publication 126, 1951, p. 83.
10. A. W. Skempton, "The Colloidal Activity of Clays," Proceedings of the 3rd International Conference of Soil Mechanics and Foundation Engineering, Vol. I, Switzerland, 1953.
11. G. A. Leonards, Editor, Foundation Engineering, McGraw Hill, New York, 1962.

12. K. Terzaghi and R. B. Peck, Soil Mechanics in Engineering Practice, 2nd Edition, John Wiley & Sons, Inc., New York, 1967.
13. T. W. Lambe and R. V. Whitman, Soil Mechanics, John Wiley & Sons, Inc., New York, 1969.
14. L. Bjerrim, Unpublished Lecture on Observed Versus Computed Settlements of Structures on Clay and Sand, Given at Massachusetts Institute of Technology, 1964.
15. T. W. Lambe, Soil Testing for Engineers, John Wiley & Sons, Inc., New York, 1951.

TABLES

TABLE 1

GAS ENCOUNTERED IN DRILL HOLES

<u>Drill Hole No</u>	<u>Depth to Gas Infiltration (ft)</u>	<u>Soil Type</u>	<u>Remarks</u>
12	118.0	Sand	Bubbles in drill fluid, gas dissipated after 24 hours, no odor
20	136.0	Sand	Bubbles in drill fluid, gas dissipated after 24 hours, no odor
30	50.0	Clay	Bubbles in drill fluid, gas dissipated after 48 hours, no odor
50	98.0	Clay	Bubbles in grout after pulling casing, gas dissipated after 24 hours, no odor
52	70.5	Sand	Bubbles in grout after pulling casing, gas dissipated after 24 hours, no odor
59	124.5	Silt	Bubbles in drill fluid, gas dissipated after 24 hours, no odor
131	104.0	Sand	Drill fluid ejected several feet above drill hole, gas dissipated after 6 hours, no odor

TABLE 2

Sheet 1 of 3

TABLE 2

Sheet 2 of 3

TABLE 2
UNCONFINED COMPRESSION TEST RESULTS
UNDISTURBED SAMPLES

BORING & SAMPLE NUMBER	DEPTH (FEET)		UNIFIED SOIL CLASSIFICATION	PARTICLE SIZE ANALYSIS							SPECIFIC GRAVITY	ATTERBERG LIMITS			NATURAL CONDITIONS			UNCONFINED COMPRESSION TEST RESULTS				REMARKS
				% FINER THAN											W _O	γ _d	γ _t	S _u	E	ε	E/S _u	
	FROM	TO		4	10	20	40	100	200	2μ		LL	PL	PI	%	PCF	PCF	PSF	10 ³ PSF	%	——	
60/8	40.6	41.0	CL									47	25	22	40	83	116	337	50	3.0	148	
60/10	50.9	51.2	CL									34	16	18	26	100	126	1255	75	15.0	60	
60/11	55.6	56.0	CL	95	89	86	84	79	76	34	2.70	33	18	15	25	103	129	1299	133	15.0	102	Sandy
60/14	75.1	75.4	CL									40	20	20	27	97	123	651	71	5.0	109	
60/19	100.1	100.4	CL									38	20	18	27	101	128	1131	100	7.0	88	Sandy
60/23	119.6	120.0	CL-ML	--	94	90	86	71	61	18	2.70	17	11	6	15	115	132	335	55	6.0	164	Sandy
101/2	8.9	9.2	CL-CH									50	22	28	28	96	123	1828	200	2.4	109	
101/4	19.6	20.2	CL-CH									49	24	25	36	86	117	1014	75	6.0	74	
101/7	34.9	35.2	CL-CH									46	24	22	40	81	113	795	55	2.4	76	
101/10	50.1	50.4	CL-CH									40	22	18	33	90	120	722	71	5.0	89	
101/13	65.2	65.6	CL									36	19	17	27	97	123	1337	43	15.0	32	
101/17	85.2	85.5	CL									37	19	18	25	97	121	1923	102	15.0	53	Sandy
119/9	81.6	81.9	CL									33	20	13	21	107	129	3072	111	15.0	36	Sandy
126/3	8.2	8.6	CL-CH									47	24	23	26	99	125	1725	208	2.4	121	
136/4	8.8	9.2	CL-CH									48	22	26	24	102	126	5446	769	3.0	141	
144/4-1	8.5	8.8	CL-CH									48	21	27	26	97	122	861	192	1.7	223	
144/4-2	8.9	9.2	CL-CH									48	21	27	24	99	123	1002	119	3.0	119	
185/3	7.5	7.8	CL-CH									50	23	27	24	104	129	2947	400	4.0	136	
185/7	18.5	18.8	CL-CH									49	22	27	39	81	113	831	94	2.4	113	
																						Sheet 3 of 3

UNCONFINED COMPRESSION TEST RESULTS

REMOLEDDED AND COMPACTED SAMPLES

[illegible]

TABLE 4

LABORATORY VANE SHEAR TEST RESULTS

[illegible]

TABLE 5

UNCONSOLIDATED-UNDRAINED TRIAXIAL TEST RESULTS
UNDISTURBED SAMPLES

BORING & SAMPLE NUMBER	DEPTH (FEET)		UNIFIED SOIL CLASSIFICATION	ATTERBERG LIMITS			NATURAL CONDITIONS			UNCONSOLIDATED UNDRAINED STRENGTH TEST					REMARKS
							W _o	γ _d	γ _t	σ _o	S _u	E	ε	E/S _u	
	FROM	TO		LL	PL	PI	%	PCF	PCF	PSF	PSF	10 ³ PSF	%	—	
15/2	3.7	4.1	CL	45	21	24	25	101	126	475	2386	240	8.0	101	
18/3	20.6	20.9	CL	44	21	23	40	83	116	2448	410	150	4.0	366	
18/6	51.4	51.7	CL	39	18	21	31	92	121	4104	827	100	3.0	121	
18/10	88.8	90.1	CL	29	15	14	17	111	130	6336	2862	240	15.0	84	Sandy
25/10	88.9	89.2	CL	36	19	17	23	104	128	6192	2213	162	11.0	73	
27/2	4.5	4.8	CL-CH	48	24	24	24	103	129	576	2099	121	8.0	58	
41/17	72.9	73.2	CL	25	15	10	20	105	126	8654	453	21	14.0	46	Sandy
48/14	60.8	61.1	CL	34	16	18	26	99	125	4608	746	36	15.0	48	Sandy
50/8	38.1	38.4	CH	55	23	32	46	74	108	3456	643	75	4.0	117	
50/10	49.3	49.6	CL	36	16	20	23	100	123	4320	721	73	15.0	101	Sandy
50/12	59.1	59.4	CL	39	18	21	24	101	125	4608	1132	218	10.0	193	Sandy
52/3	21.2	21.5	CL-CH	49	20	29	31	92	121	2016	1590	157	8.0	99	
52/8	69.0	69.4	CL	24	14	10	16	111	129	5184	1890	127	15.0	66	Sandy
52/9	78.6	78.9	CL	35	18	17	22	105	128	5760	1156	130	14.0	112	
52/12	109.3	109.6	CL	46	22	24	36	87	118	7632	1586	230	3.0	145	
53/3	20.1	20.4	CL-CH	49	20	29	32	91	120	2405	1425	176	8.9	124	
53/4	30.1	30.4	CL-CH	49	22	27	34	88	118	3024	972	200	2.4	206	
54/4	53.2	53.5	ML-CL	21	17	4	24	99	123	4320	533	54	15.0	101	
54/5	59.0	59.3	CL	38	17	21	25	99	124	4464	767	35	15.0	46	Sandy
54/6	63.1	63.4	CL	36	18	18	26	98	123	5040	796	100	13.0	126	Sandy
54/7	68.8	69.1	CL	37	18	19	26	98	123	5112	1148	142	12.0	124	Sandy
101/15	74.6	74.9	CL	36	21	15	23	105	129	5328	1054	44	15.0	42	Sandy
101/19	94.9	95.3	CL	36	20	16	25	100	125	6480	547	32	15.0	59	
101/23	119.8	120.2	CL	44	22	22	37	85	116	7920	721	70	8.0	97	

TABLE 5

Sheet 2 of 2

TABLE 6
CONSOLIDATED-UNDRAINED TEST RESULTS
UNDISTURBED SAMPLES

BORING & SAMPLE NUMBER	DEPTH (FEET)		UNIFIED SOIL CLASSIFICATION	ATTERBERG LIMITS			NATURAL CONDITIONS			CONSOLIDATION CONDITIONS	CONDITIONS AFTER CONSOLIDATION		CONSOLIDATED UNDRAINED STRENGTH TEST			SKEMPTON'S A PARAMETER (FINAL)	SHEAR STRENGTH PARAMETERS			
							W _O	γ _d	γ _t	σ ₃	W _f	γ _{tf}	E	(σ ₁ -σ ₃) ¹	E/S _u		TOTAL STRESS		EFFECTIVE STRESS	
	φ	C		φ'	C'															
	FROM	TO		LL	PL	PI	%	PCF	PCF	PSF	%	PCF	10 ³ PSF	PSF	—		deg.	PSF	deg.	PSF
18/12	108	110	CL	46	22	24	35	87	117	3,744	33.7	116	316	3,900	161	0.28	10	900	22	300
							31	92	120	7,488	29.3	119	400	5,200	154	0.68				
							31	92	120	15,120	27.7	117	1,500	8,170	367	1.04				
26/2	3.5	5.5	CL-CH	53	24	29	23	104	127	360	27	132	225	2,200	204	0.15	34	350	27	320
							24	103	128	691	27	131	346	3,450	200	0.19				
							22	108	132	1,296	25	135	450	4,800	187	0.20				
26/5	18	20	CL-CH	--	--	--	35	89	120	1,080	31	116	125	1,350	185	0.23	16	250	27	50
							35	86	116	2,160	31	113	273	1,680	325	0.72				
							36	86	117	5,040	28	110	500	4,350	230	0.56				
26/11	48	50	CL	41	21	20	36	88	120	2,304	34	118	250	1,790	279	0.57	9	400	24	0
							37	86	118	4,608	23	106	666	2,440	546	1.11				
							30	93	121	9,216	24	115	666	4,410	302	1.34				
33/7	28	30.5	CL	46	22	24	39	82	114	1,440	37	112	300	1,480	405	0.39	10	300	24	0
							40	82	115	2,880	37	112	750	1,930	776	0.77				
							38	84	116	5,760	32	111	500	3,040	328	1.17				
33/9	38.0	40.5	CL	43	23	20	37	83	114	7,200	36	113	175	1,600	110	0.51	9	400	22	150
							37	85	116	7,200	34	114	300	2,160	277	0.93				
							36	86	117	12,960	31	113	300	3,320	180	1.31				
48/6	18.0	20.0	CL-CH	47	25	22	33	90	120	1,152	32	119	166	1,860	179	0.05	9	700	21	300
							34	89	119	2,304	33	118	375	2,610	287	0.24				
							36	88	120	4,608	31	115	500	3,160	316	0.78				
48/22	98	100	CL	36	19	17	27	99	126	3,312	25	124	375	4,030	186	0.19	11	1050	25	0
							26	96	121	6,624	24	119	666	5,760	231	0.49				
							28	97	124	13,248	23	119	1,200	8,820	272	0.83				
																	Sheet 1 of 4			

TABLE 6
CONSOLIDATED-UNDRAINED TEST RESULTS
UNDISTURBED SAMPLES

BORING & SAMPLE NUMBER	DEPTH (FEET)		UNIFIED SOIL CLASSIFICATION	ATTERBERG LIMITS			NATURAL CONDITIONS			CONSOLIDATION CONDITIONS	CONDITIONS AFTER CONSOLIDATION		CONSOLIDATED UNDRAINED STRENGTH TEST			SKEMPTON'S A PARAMETER (FINAL)	SHEAR STRENGTH PARAMETERS			
							W _O	γ _d	γ _t	σ ₃	W _f	γ _{tf}	E	(σ ₁ -σ ₃) ¹	E/S _u		TOTAL STRESS		EFFECTIVE STRESS	
	φ	C		φ'	C'															
	FROM	TO		LL	PL	PI	%	PCF	PCF	PSF	%	PCF	10 ³ PSF	PSF	—		deg.	PSF	deg.	PSF
49/6	43	45	CL-CH	53	22	31	44	78	112	1,872	42	111	158	1,840	172	0.46	9	500	22	200
							46	75	110	3,744	45	109	333	2,710	246	0.70				
							45	77	112	7,488	39	107	583	3,860	311	1.10				
49/13	113.0	115.0	CL	33	22	11	24	100	124	3,816	23	123	400	3,570	223	0.43	10	900	25	0
							29	95	123	7,632	27	121	666	4,850	274	0.87				
							29	93	120	15,264	24	115	857	8,260	207	1.16				
50/6	28.0	30.0	CL	39	18	21	33	88	117	1,440	32	116	250	1,680	296	0.32	11	450	26	100
							33	90	120	2,880	27	114	300	2,100	285	0.74				
							34	86	115	5,760	29	111	500	3,440	291	1.06				
50/18	88.0	90.0	CL	39	23	16	28	97	124	3,456	26	122	214	3,850	111	0.27	10	900	25	200
							28	97	124	6,912	26	122	461	5,180	178	0.69				
							28	96	123	13,824	23	118	461	7,980	115	1.01				
54/4	53.0	55.0	CL	31	18	13	23	102	125	4,320	21	123	500	4,040	247	0.42	15	450	26	0
							23	102	125	8,640	20	122	461	7,730	119	0.50				
							23	101	124	2,160	22	123	285	2,860	199	0.11				
							24	100	124	6,480	20	120	666	5,610	237	0.55				
52/6	48.0	50.5	ML	--	--	--	21	101	122	2,160	22	123	533	30,320	35	0.29	42	4,000	36	0
							23	99	122	4,320	22	121	1,000	35,020	57	0.24				
							22	104	127	8,640	22	127	1,000	55,550	36	0.18				
54/6	63.0	65.0	CL	36	18	18	26	98	123	2,448	26	123	166	2,730	122	0.30	11	700	25	150
							25	98	123	4,896	23	120	562	4,010	280	0.61				
							26	98	123	9,792	22	119	900	5,860	307	1.00				
60/2	8.0	10.0	CH	53	26	27	30	94	118	590	32	124	157	1,060	298	0.01	18	260	22	170
							29	95	123	1,152	31	124	273	1,750	301	0.09				
							29	96	124	2,304	30	125	375	2,670	280	0.16				
Sheet 2 of 4																				

TABLE 6
CONSOLIDATED-UNDRAINED TEST RESULTS
UNDISTURBED SAMPLES

BORING & SAMPLE NUMBER	DEPTH (FEET)		UNIFIED SOIL CLASSIFICATION	ATTERBERG LIMITS			NATURAL CONDITIONS			CONSOLIDATION CONDITIONS	CONDITIONS AFTER CONSOLIDATION		CONSOLIDATED UNDRAINED STRENGTH TEST			SKEMPTON'S A PARAMETER (FINAL)	SHEAR STRENGTH PARAMETERS					
							W _o	γ _d	γ _t	$\bar{\sigma}_3$	W _f	γ _{tf}	E	(σ ₁ -σ ₃) ¹	E/S _u		TOTAL STRESS		EFFECTIVE STRESS			
	LL	PL		PI	%	PCF											PCF	PSF	%	PCF	10 ³ PSF	PSF
	FROM	TO		deg.	PSF	deg.	PSF															
Remolded																						
60/2	8.0	10.0	CH	53	26	27	29	96	124	560	29	124	100	1,750	114	-0.18	19	450	27	125		
							29	99	128	1,152	26	125	187	2,490	150	0.10						
							29	98	126	2,304	26	123	214	3,500	122	-0.04						
60/4	21.0	23.0	CL	43	17	26	30	94	122	1,296	31	123	102	2,780	73	-0.09	13	800	24	250		
							31	94	123	5,184	30	122	900	5,130	350	0.37						
							31	95	124	2,016	30	123	281	3,180	177	0.07						
60/9	45.0	47.0	CL	38	16	22	27	99	126	2,016	26	125	500	2,530	394	0.24	10	600	25	100		
							27	98	124	4,032	26	123	321	2,990	214	0.72						
							26	102	129	8,064	23	125	750	5,020	298	0.97						
60/13	67.0	69.0	CL-ML	40	19	21	24	103	128	2,520	22	126	180	3,890	93	0.12	13	1,000	25	0		
							32	91	120	5,040	28	116	462	3,445	268	0.70						
							20	104	125	10,080	18	123	923	8,120	227	0.56						
							16	114	132	5,760	15	131	923	9,225	200	0.13						
							21	104	126	8,640	19	124	545	6,357	171	0.72						
105/2	9.0	11.0	CL	46	24	22	26	99	125	1,152	28	127	113	2,453	92	-0.05	27	150	25	250		
							27	96	122	2,304	28	123	389	4,381	177	-0.05						
							28	98	125	864	29	126	250	2,377	210	-0.02						
105/5	40.0	42.5	CL	44	21	23	36	84	114	1,800	35	113	196	2,136	183	0.29	8	700	23	0		
							36	85	116	3,600	34	114	450	2,753	327	0.56						
							35	85	115	7,200	31	111	900	3,660	491	1.13						
							39	84	117	7,200	33	112	643	3,803	169	1.12						
119/2	8.0	10.0	CL-CH	53	26	27	28	95	122	576	29	122	245	1,773	138	0.00	22	375	26	290		
							28	99	127	2,304	28	127	450	4,024	223	0.09						
							29	94	121	1,440	30	122	245	2,481	99	0.17						
																			Sheet 3 of 4			

TABLE 6
CONSOLIDATED-UNDRAINED TEST RESULTS
UNDISTURBED SAMPLES

BORING & SAMPLE NUMBER	DEPTH (FEET)		UNIFIED SOIL CLASSIFICATION	ATTERBERG LIMITS			NATURAL CONDITIONS			CONSOLIDATION CONDITIONS	CONDITIONS AFTER CONSOLIDATION		CONSOLIDATED UNDRAINED STRENGTH TEST			SKEMPTON'S A PARAMETER (FINAL)	SHEAR STRENGTH PARAMETERS			
							W _o	γ _d	γ _t	σ ₃	W _f	γ _{tf}	E	(σ ₁ -σ ₃) ¹	E/S _u		TOTAL STRESS		EFFECTIVE STRESS	
	φ	C		φ'	C'															
	FROM	TO		LL	PL	PI	%	PCF	PCF	PSF	%	PCF	10 ³ PSF	PSF	—		deg.	PSF	deg.	PSF
119/4	30.0	32.0	CL	41	22	19	37	86	118	1,512	35	116	333	1,970	333	0.24	8	700	26	50
							39	85	118	3,024	36	116	500	2,460	406	0.57				
							35	87	117	6,048	30	113	375	3,310	226	1.20				
129/5	18.0	21.0	CL-CH	48	21	27	34	90	121	1,152	33	120	136	2,200	123	-0.03	14	450	24	0
							32	90	119	4,608	--	--	346	4,170	165	0.42				
							33	90	120	2,304	32	119	750	2,550	588	0.26				
129/19	93.0	95.5	CL	41	21	20	24	99	123	3,240	22	121	187	3,035	123	0.45	13	500	26	0
							26	99	125	6,480	23	122	500	6,090	164	0.44				
							27	99	126	12,960	22	121	750	8,900	168	0.81				
141/4	18.0	20.0	CL	45	21	24	36	86	117	1,152	36	117	180	2,079	173	0.15	9	750	21	350
							36	87	118	2,304	35	117	818	2,780	587	0.29				
							*35 37	85 84	115 115	4,608 4,637	31 34	111 113	529 529	3,249 3,251	326 325	0.73 0.79				
158/4	17.5	20.0	CL	46	19	25	38	83	114	1,080	37	114	600	1,569	765	0.17	8	550	21	200
							34	87	117	2,160	32	115	214	1,942	220	0.51				
							37	83	114	4,320	33	110	428	2,593	330	0.95				
101,105 127,128 180,183 Combined Samples	2.0	10.0	CL-CH	--	--	--	15	113	130	1,008	21	137	150	4,261	70	-0.38	34	500	24	250
							16	114	132	2,016	19	136	210	7,531	56	-0.43				
							16	114	132	3,168	18	134	276	10,123	54	-0.39				
NOTES: 1At peak stress or at 15% strain, whichever is smaller. * Two tests run on same sample. Second test run after rebounding first sample to original consolidation pressure.																				

Sheet 4 of 4

TABLE 7
CONSOLIDATION TEST RESULTS
UNDISTURBED SAMPLES

BORING & SAMPLE NUMBER	DEPTH (FEET)		UNIFIED SOIL CLASSIFICATION	PARTICLE SIZE ANALYSIS				SPECIFIC GRAVITY	ATTERBERG LIMITS			NATURAL CONDITIONS				P _c 10 ³ PSF	C _c —	C _r —	SETTLEMENT PARAMETERS		REMARKS
				% FINER THAN								W _o	γ _d	γ _t	e _o				C _c	C _r	
	FROM	TO		40	100	200	2μ		LL	PL	PI	%	PCF	PCF	—				1 + e _o	1 + e _o	
27/10	34.0	34.5	CL					2.73	41	22	19	39	84	117	1.02	3.4	0.44	0.10	0.22	0.05	
27/24	104.2	104.5	CL					2.74	43	25	18	34	90	121	0.91	8.0	0.31	0.10	0.16	0.05	Silty Clay, Sandy
38/4*	14.6	14.7	CL-CH	-	-	98	60	2.71	46	22	24	29	96	124	0.77	10.0	0.19	0.06	0.11	0.03	
38/16	74.0	74.1	CH	-	-	98	60	2.72	55	24	31	36	87	118	0.94	9.4	0.38	0.06	0.20	0.03	
41/5*	10.8	11.0	CL-CH	-	-	98	57	2.72	46	23	23	30	94	122	0.80	11.9	0.23	0.08	0.13	0.04	
41/7	21.0	21.1	CL-CH					2.70	47	24	23	38	82	113	1.06	2.5	0.34	0.09	0.17	0.04	
41/13	53.0	53.2	CL-CH					2.75	52	25	27	47	77	113	1.24	3.5	0.35	0.10	0.16	0.04	
41/17	73.3	73.5	CL	85	74	65	24	2.68	25	15	10	27	98	124	0.70	5.3	0.21	0.05	0.12	0.03	Silty Clay, Sandy
41/25*	113.0	113.2	CL					2.71	29	19	10	24	103	128	0.64	9.4	0.18	0.05	0.11	0.03	Silty Clay, Sandy
41/29*	130.9	131.1	GC-SC					2.69	25	17	8	11	123	137	0.37	10.0	0.10	0.04	0.07	0.03	Clayey Sand, Gravelly
48/10	39.2	39.4	CL-CH					2.73	47	24	23	39	84	117	1.03	4.0	0.33	0.09	0.16	0.04	
49/3	13.7	14.0	CL-CH					2.72	47	23	24	33	91	121	0.86	6.4	0.26	0.07	0.14	0.04	
49/11*	93.8	94.0	CL					2.68	37	22	15	29	98	126	0.70	5.6	0.20	0.05	0.12	0.03	
50/8	38.5	38.9	CH					2.75	55	23	32	52	72	109	1.38	4.0	0.55	0.12	0.23	0.05	
52/4	29.9	30.2	CL-CH					2.70	49	20	29	41	84	118	1.01	4.4	0.45	0.09	0.22	0.04	
53/5	39.5	39.8	CL	85	76	66	30	2.72	39	20	19	31	91	119	0.87	6.5	0.30	0.09	0.16	0.05	Silty Clay, Sandy
54/6*	63.5	63.8	CL	89	83	77	33	2.71	36	18	18	26	99	125	0.70	6.2	0.24	0.07	0.14	0.04	Silty Clay, Sandy
54/8	73.7	74.0	CL	96	94	92	46	2.73	45	21	24	39	86	120	0.98	5.6	0.41	0.08	0.21	0.04	
60/2*	9.8	10.0	CL-CH	-	-	-	60	2.71	53	26	27	30	94	122	0.79	9.2	0.23	0.07	0.13	0.04	
60/16*	85.2	85.4	CL	83	80	78	34	2.73	40	19	21	28	98	125	0.74	9.0	0.27	0.07	0.16	0.04	
105/1*	5.1	5.4	CH					2.72	53	24	29	24	103	128	0.64	4.0	0.10	0.05	0.06	0.03	
105/8	70.9	71.2	CL					2.70	37	19	18	24	103	128	0.63	7.2	0.21	0.06	0.13	0.04	Sheet 1 of 2
118/5	38.6	38.9	CL					2.70	41	22	19	37	86	118	0.97	4.6	0.39	0.10	0.20	0.05	* INDICATES SAMPLES BELIEVED TO BE RELATIVELY DISTURBED.
118/9*	78.7	79.0	CL					2.70	42	23	19	28	97	124	0.74	8.6	0.24	0.06	0.14	0.03	

TABLE 7
CONSOLIDATION TEST RESULTS
UNDISTURBED SAMPLES

[illegible]

TABLE 8
CONSOLIDATION TEST RESULTS
REMOLDED SAMPLES

[illegible]

TABLE 9
PERMEABILITY TEST RESULTS
UNDISTURBED SAMPLES

[illegible]

TABLE 10
RECOMMENDED DESIGN PROPERTIES FOR SITE SOILS

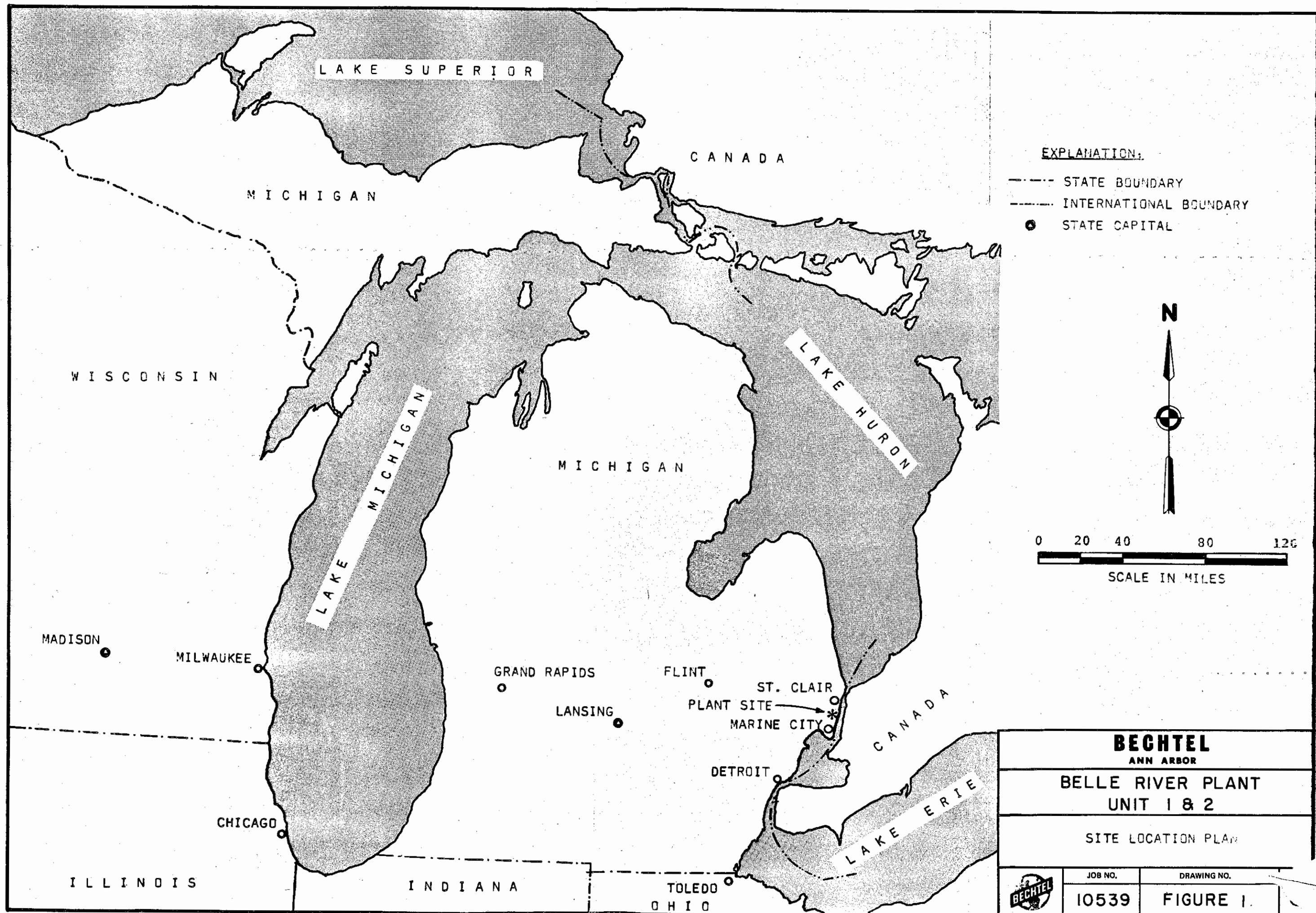
Static Properties	Upper Stratum ¹ 0 - 20 Ft	Middle Stratum ¹ 20 - 50 Ft	Lower Stratum ¹ 50 + Ft
In Situ Total Density (PCF)	125	115	125
In Situ Moisture Content (%)	25	35	25
Degree of Saturation (%)	100	100	100
Specific Gravity	2.72	2.72	2.71
Poisson's Ratio ²			
Drained	0.4	0.4	0.4
Undrained	0.5	0.5	0.5
Initial Modulus of Elasticity (KSF)	700	330	350
Maximum Dry Density per ASTM 1557	118-112 ³	-	-
Optimum Moisture Content	13-16 ³	-	-
Permeability (cm/sec x 10 ⁻⁸)	2	2	2
Unconfined Compression Shear Strength			
Cohesion (PSF)	550	550	850
Consolidated Undrained Shear Strength			
Effective Stress Basis			
ϕ' (Deg.)	28	28	25
c' (PSF)	0	0	0
Total Stress Basis			
ϕ (Deg.)	13	13	10
c (PSF)	460	460	710
Settlement Parameter $C_c/1+e_0$	0.13	0.20	0.14
Coefficient of Consolidation (C_v) Ft ² /day	0.15	0.15	0.15

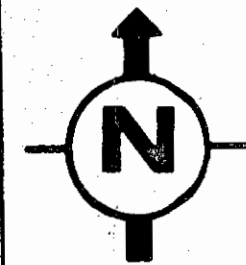
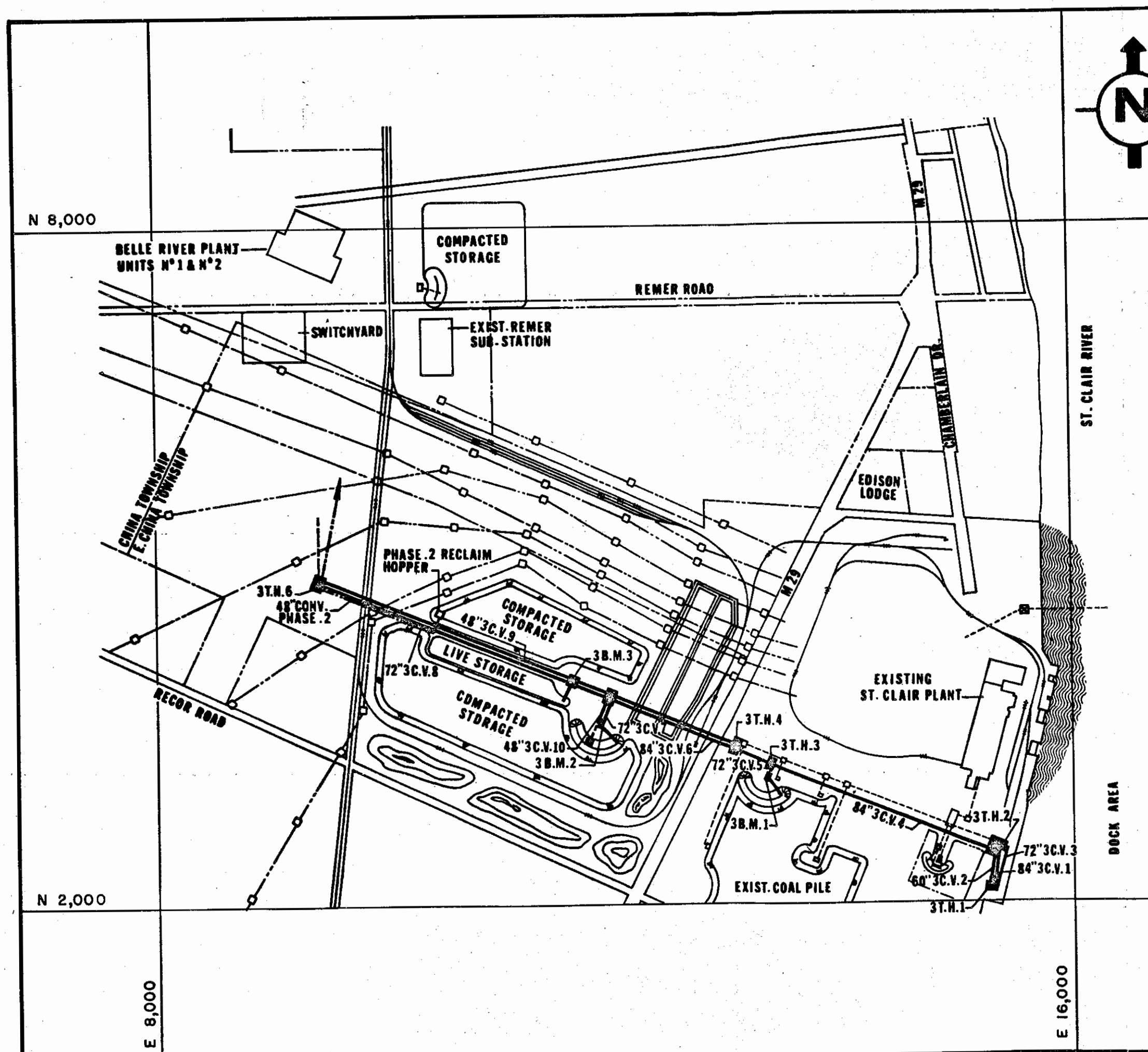
¹The depths of the different strata are approximate (see text).


²Typical values.

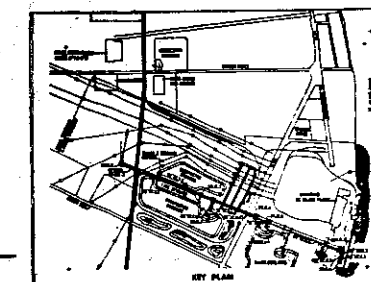
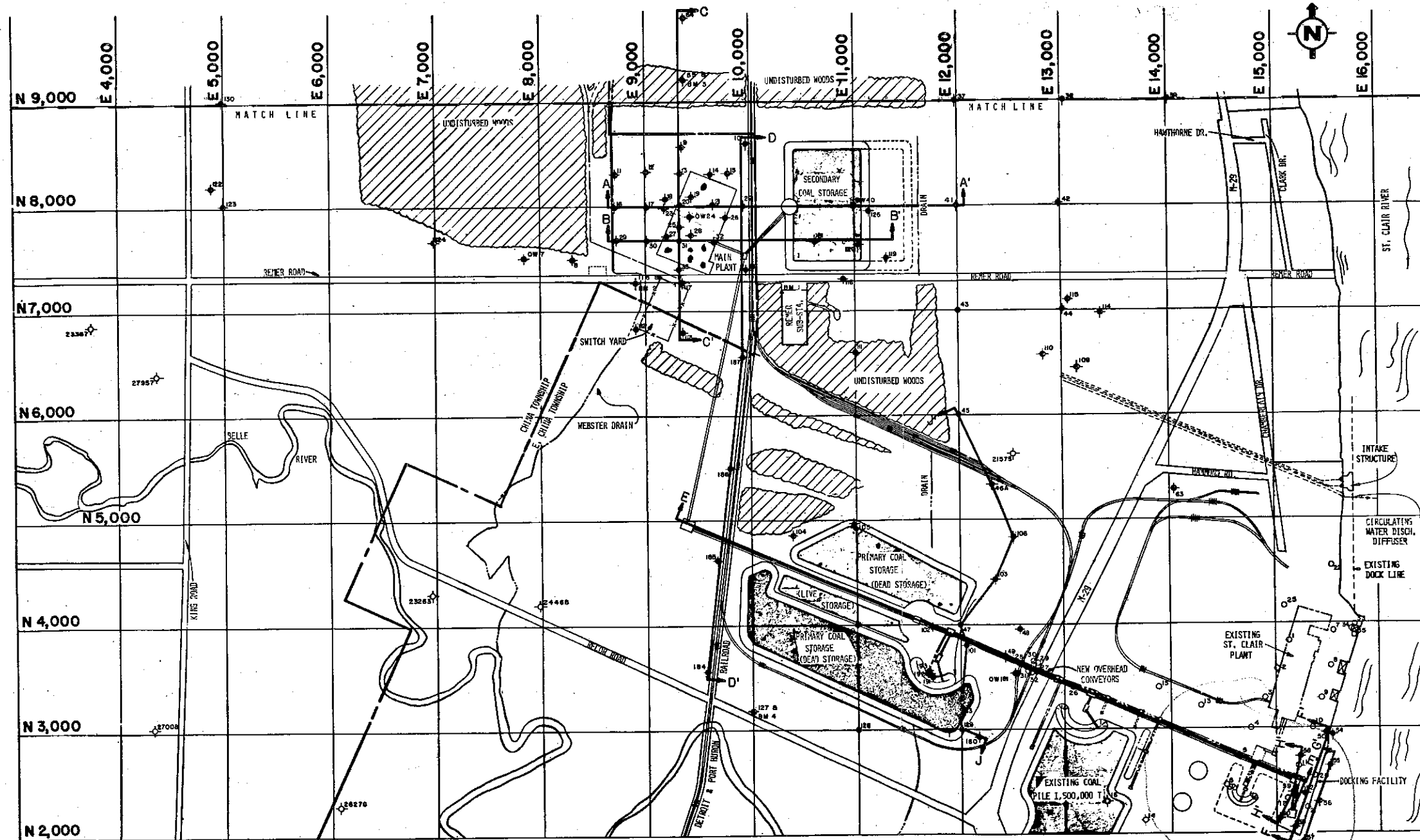
³Refer to Figure 40 for additional information.

FIGURES





BECHTEL ANN ARBOR			
BELLE RIVER PLANT COAL HANDLING SYSTEM PHASE 1			
SITE PLAN			
	JOB NO.	DRAWING NO.	REV.
	10539	FIGURE 2	O

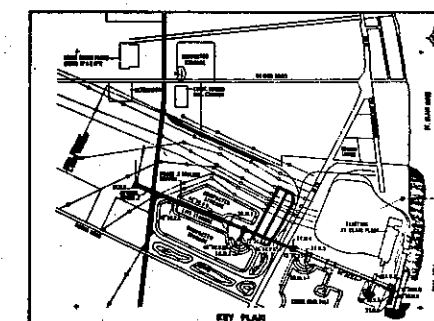
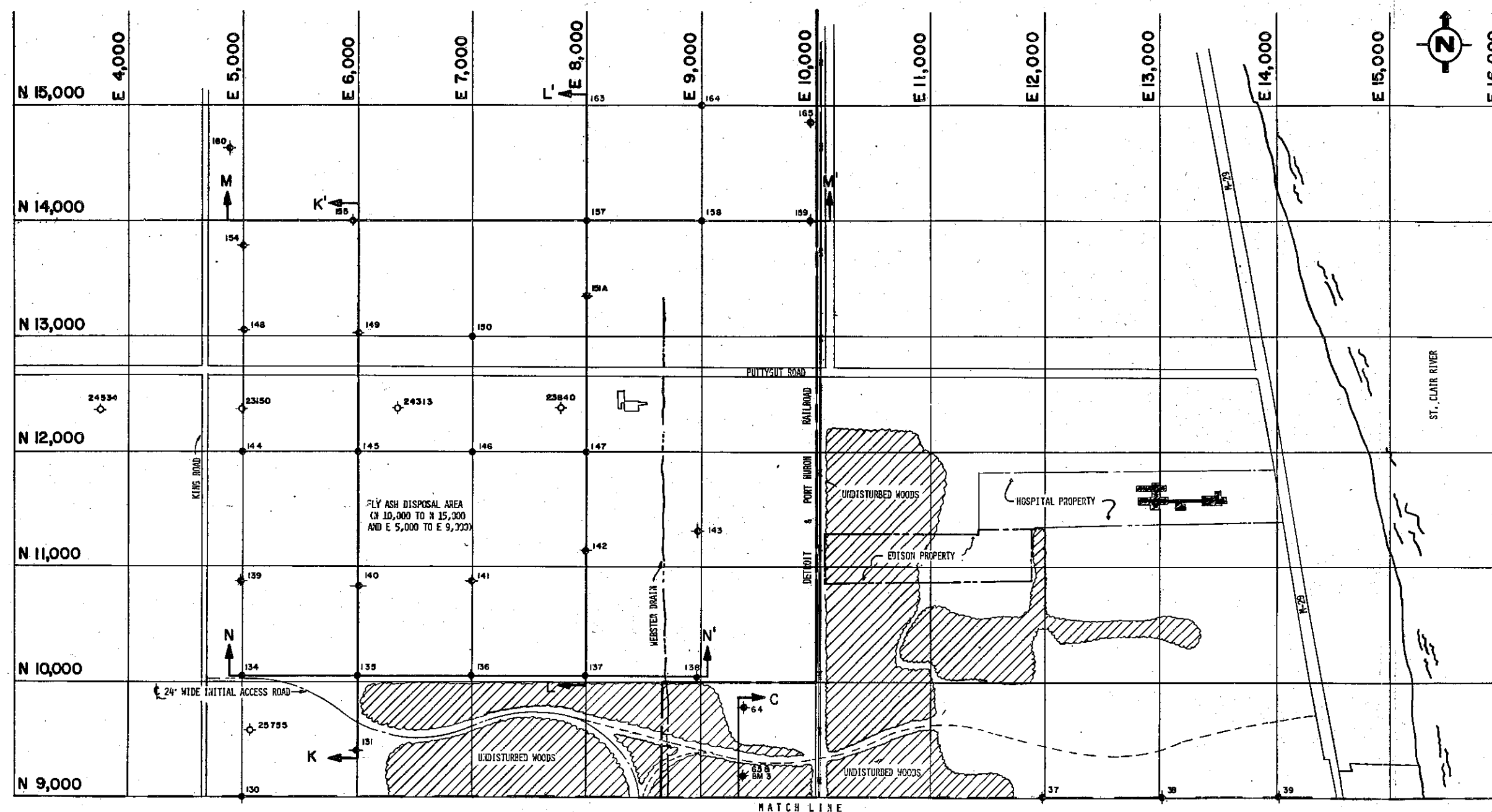


- NOTES:
1. FOR SUBSURFACE PROFILES SEE FIGURE 9, A THROUGH H.
 2. SECTIONS A, B, AND C ARE BASED ON ORIGINAL PLANT LOCATION.
 3. SEE FIGURE 4 FOR ADDITIONAL BORING LOCATIONS.

EXPLANATION

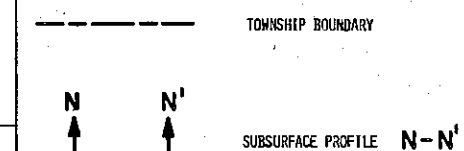
- TOWNSHIP BOUNDARY
- N N' SUBSURFACE PROFILE N-N'
- 18.7 BORING LOCATION
- OW DENOTES OBSERVATION WELL
- BM BENCH MARK
- 38 BORING LOCATIONS FROM PREVIOUS INVESTIGATIONS FOR ST. CLAIR PLANT
- 202787 WELLS DRILLED FOR OIL OR GAS EXPLORATION - SHOWING PERMIT NUMBER (ALL HOLES WERE DRY)
- 0 100 200 400 800 1200 Feet
SCALE

BECHTEL ANN ARBOR			
BELLE RIVER PLANT UNIT 1 & 2			
BORING LOCATION PLAN SOUTH AREA			
BECHTEL	JOB NO.	DRAWING NO.	REV.
	10539	FIGURE 3	2



- NOTES:
1. FOR SUBSURFACE PROFILES, SEE FIGURE 9, A THROUGH H.
 2. SEE FIGURE 3 FOR ADDITIONAL BORING LOCATIONS.

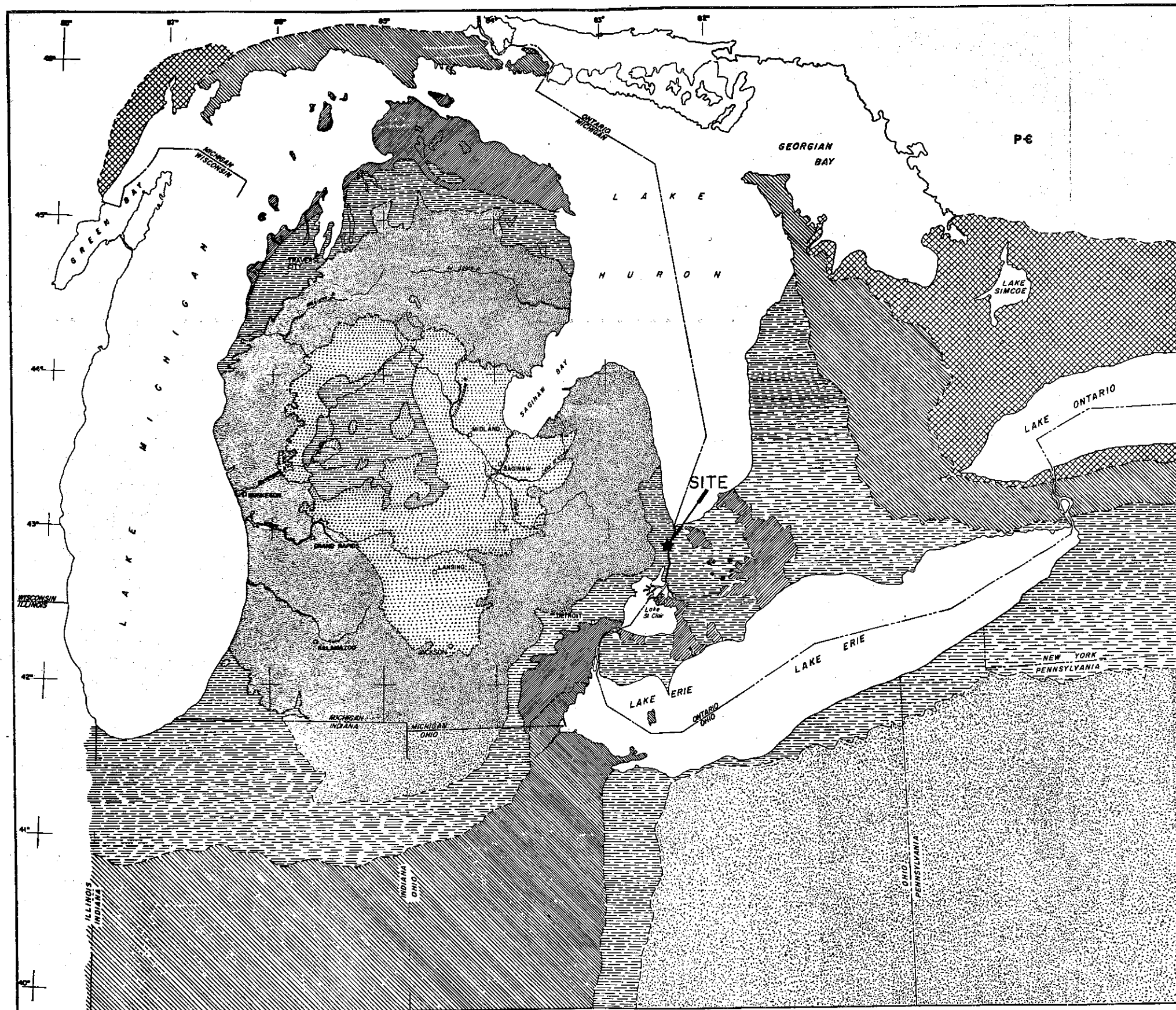
EXPLANATION



- BORING LOCATION FROM THIS INVESTIGATION
- BENCH MARK
- WELLS DRILLED FOR OIL OR GAS
EXPLORATION - SHOWING PERMIT NUMBER
(ALL HOLES WERE DRY)

0 400 800 1200
SCALE IN FEET

BECHTEL ANN ARBOR		
BELLE RIVER PLANT UNIT 1 & 2		
BORING LOCATION PLAN NORTH AREA		
JOB NO.	DRAWING NO.	REV.
10539	FIGURE 4	1



EXPLANATION

MESOZOIC	JURASSIC		Former "Permian-Carboniferous red beds"; shale, clay and sandy shales.
			Grand River Formation and Saginaw Formation; chiefly sandstone, some shaly limestone and coal.
PALEOZOIC	PENNSYLVANIAN		Grand Rapids Group, Marshall Sandstone and Coldwater Shale; chiefly shale and dolomitic shale, some limestone and sandstone.
			Ellsworth Shale, Bedford Shale, and Antrim Shale; shale with some sandstone.
	DEVONIAN		Traverse Group and Detroit River Group; chiefly limestone and dolomite, some shale, sandstone and salt.
			Bass Islands Group, Sable Group, Monticue Group, Burnt Bluff Group, and Cataract Group; dolomitic shale, dolomite and limestone, some salt.
PRE CAMBRIAN	SILURIAN		Undifferentiated; shale, siltstone, limestone and dolomite.
	ORDOVICIAN		P-6 Undifferentiated; complex sequence of metamorphosed igneous and sedimentary rocks.

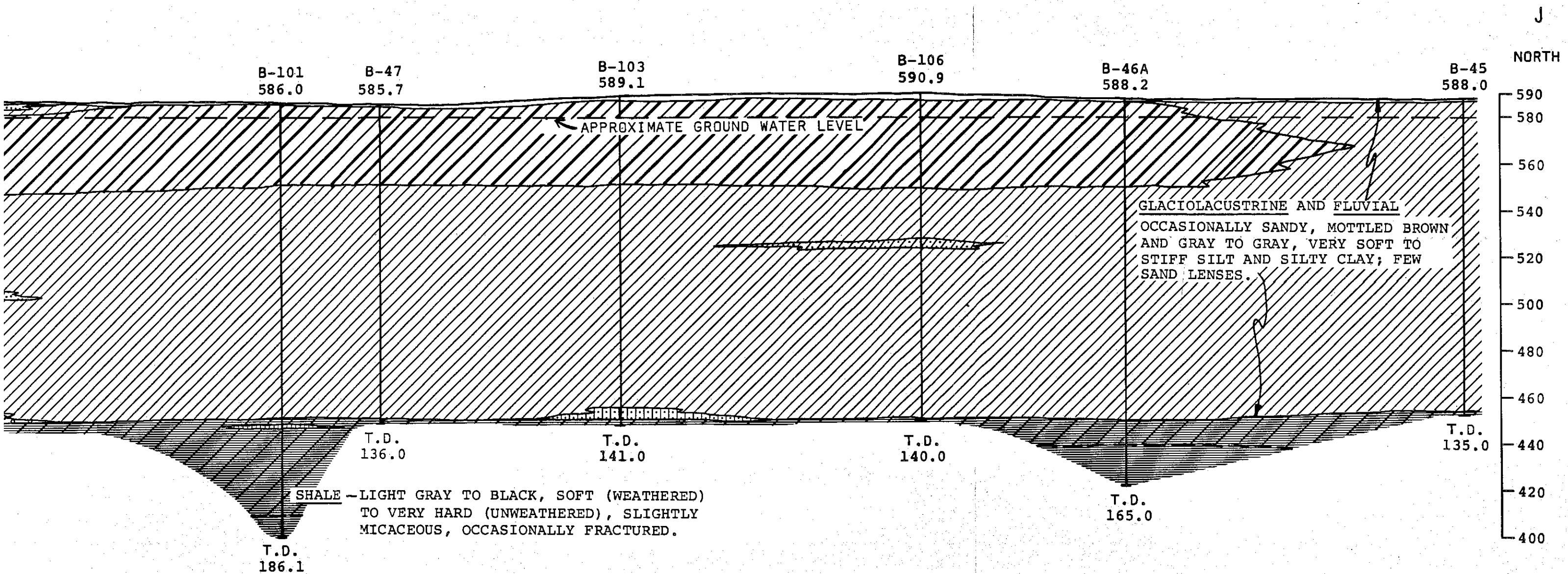
NOTE:

Geology is generalized from the following:

- (1) The Centennial Geologic Map of the Southern Peninsula of Michigan, 1936, Mich. Geol. Survey.
- (2) Stratigraphic Succession in Michigan, Chart I, 1964, Mich. Geol. Survey.
- (3) Bedrock of Michigan, Small Scale Map 2, 1968, Mich. Geol. Survey.
- (4) Geology of Toronto - Windsor Area, 1969, Geological Survey of Canada.
- (5) Geologic Map of North America, 1965, U.S. Geological Survey.

10 0 10 20 30 40 50
SCALE IN MILES

BECHTEL SAN FRANCISCO		
BELLE RIVER POWER PLANT UNITS 1 & 2		
BEDROCK GEOLOGY LOWER PENINSULA MICHIGAN		
	JOB NO. 10539	DRAWING NO. FIGURE 5
		REV. 0



ND

EXPLANATION

- Clayey Sand (SC)
- Silty Sand (SM)
- Silt (ML)
- Shale (weathered)

B-187 Bechtel borings (1973-1974)
T.D. Total depth drilled (ft)

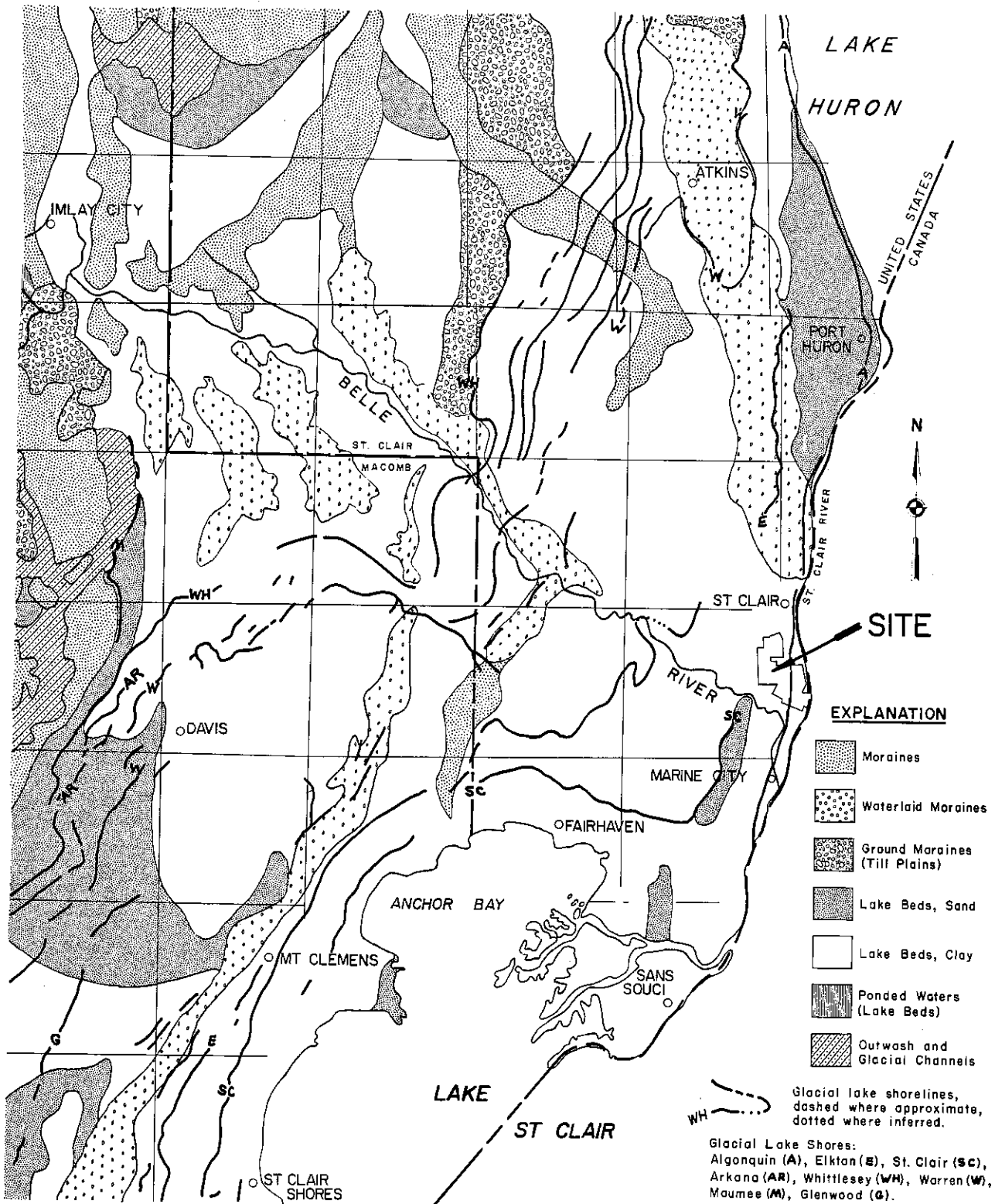


NOTES:

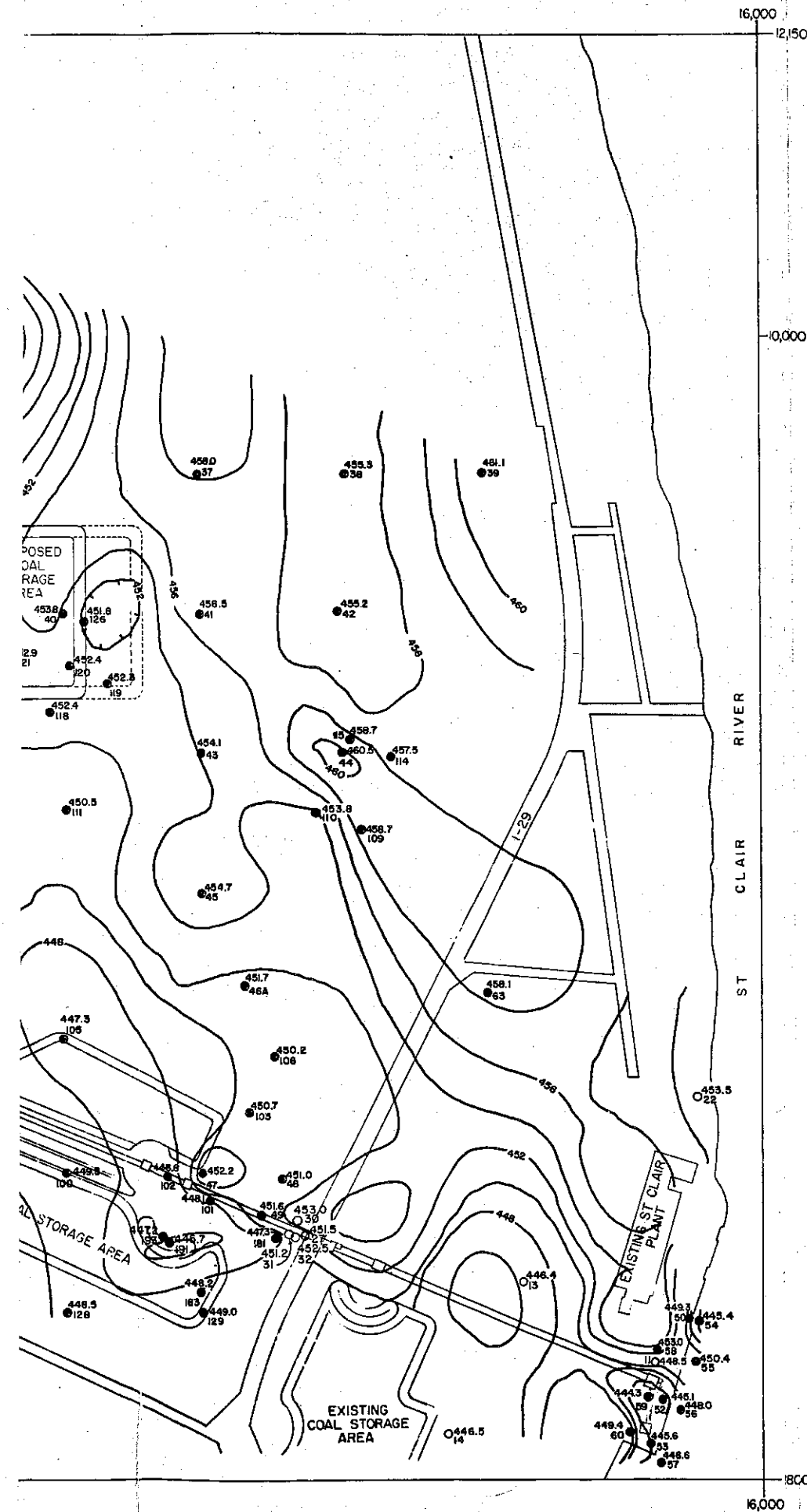
- 1.) For location of section see Figure 3.
- 2.) For variation of water table see Section 4.1.3.
- 3.) For boring logs see Appendix B.
- 4.) For Geologic description of site see Section 4.1.2.

hale (unweathered)

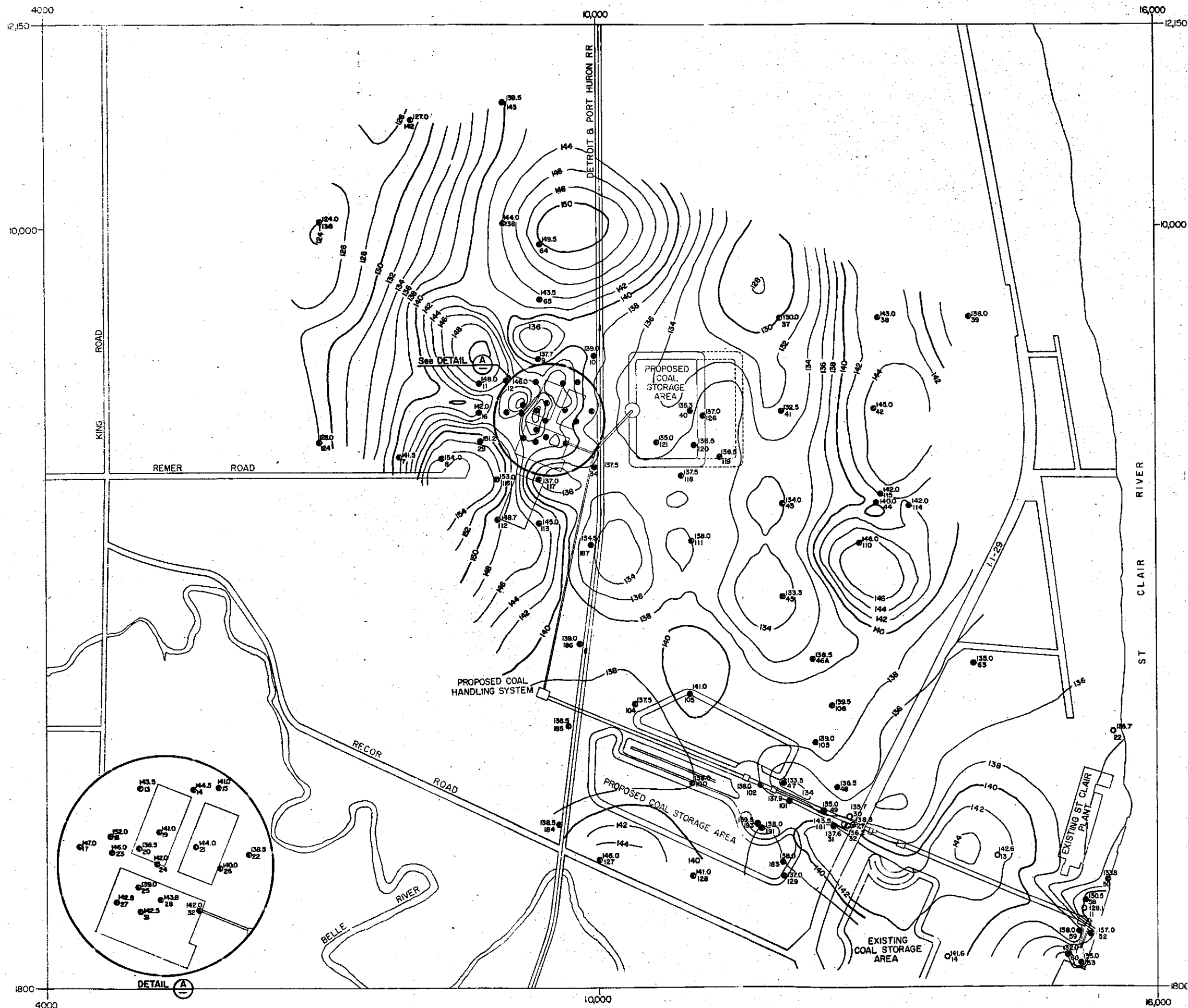
BECHTEL ANN ARBOR			
BELLE RIVER PLANT UNIT 1 & 2			
SUBSURFACE PROFILE SECTION J-J'			
	JOB NO.	DRAWING NO.	REV.
	10539	FIGURE 9	○



BECHTEL ANN ARBOR			
BELLE RIVER PLANT UNIT 1 & 2			
SURFICIAL GEOLOGY			
ST. CLAIR AND MACOMB COUNTIES			
	JOB NO. 10539	DRAWING NO. FIGURE 6	REV. 0



BECHTEL ANN ARBOR			
BELLE RIVER PLANT UNIT 1 & 2			
TOP OF ROCK CONTOUR MAP			
	JOB NO. 10539	DRAWING NO. FIGURE 7	REV. 1



EXPLANATION

- 134.5 — Overburden thickness (ft)
- 187 — Boring number (present investigation)
- 136.2 — Overburden thickness (ft)
- 132 — Boring number (previous investigations for St. Clair plant)
- 150 — Line through points of equal thickness of overburden in feet

NOTES:

1. Thickness contours generated from drill hole data by McDonnell Douglas Automation Company's SURMAP computer program.
2. Computer interpretation modified manually to accommodate additional data points.
3. Detail A (plant area) enlarged for clarity, to twice graphic scale shown below.



0 200 400 800 1200
SCALE IN FEET

THICKNESS INTERVAL = 2 FT

BECHTEL
ANN ARBOR

**BELLE RIVER PLANT
UNIT 1 & 2**

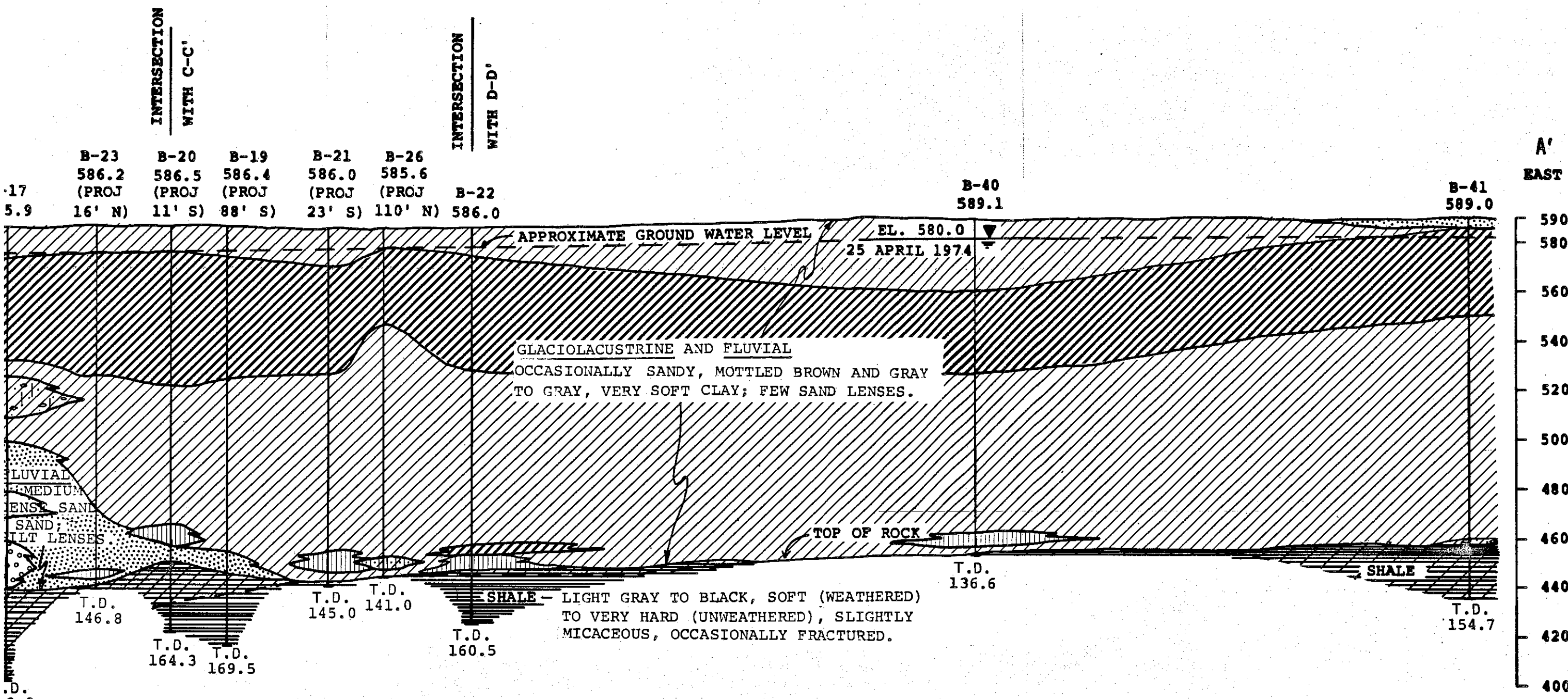
**OVERBURDEN THICKNESS
CONTOUR MAP**



JOB NO.
10539

DRAWING NO.
FIGURE 8

REV.
1



PLANT AREA - PRECIPITATORS AND COAL STORAGE AREA

LEGEND

- 1) Clayey Sand (SC)
- 4) Silty Sand (SM)
- 2) Gravel (GM)
- 3) Shale (weathered)
- 5) Shale (unweathered)

EXPLANATION

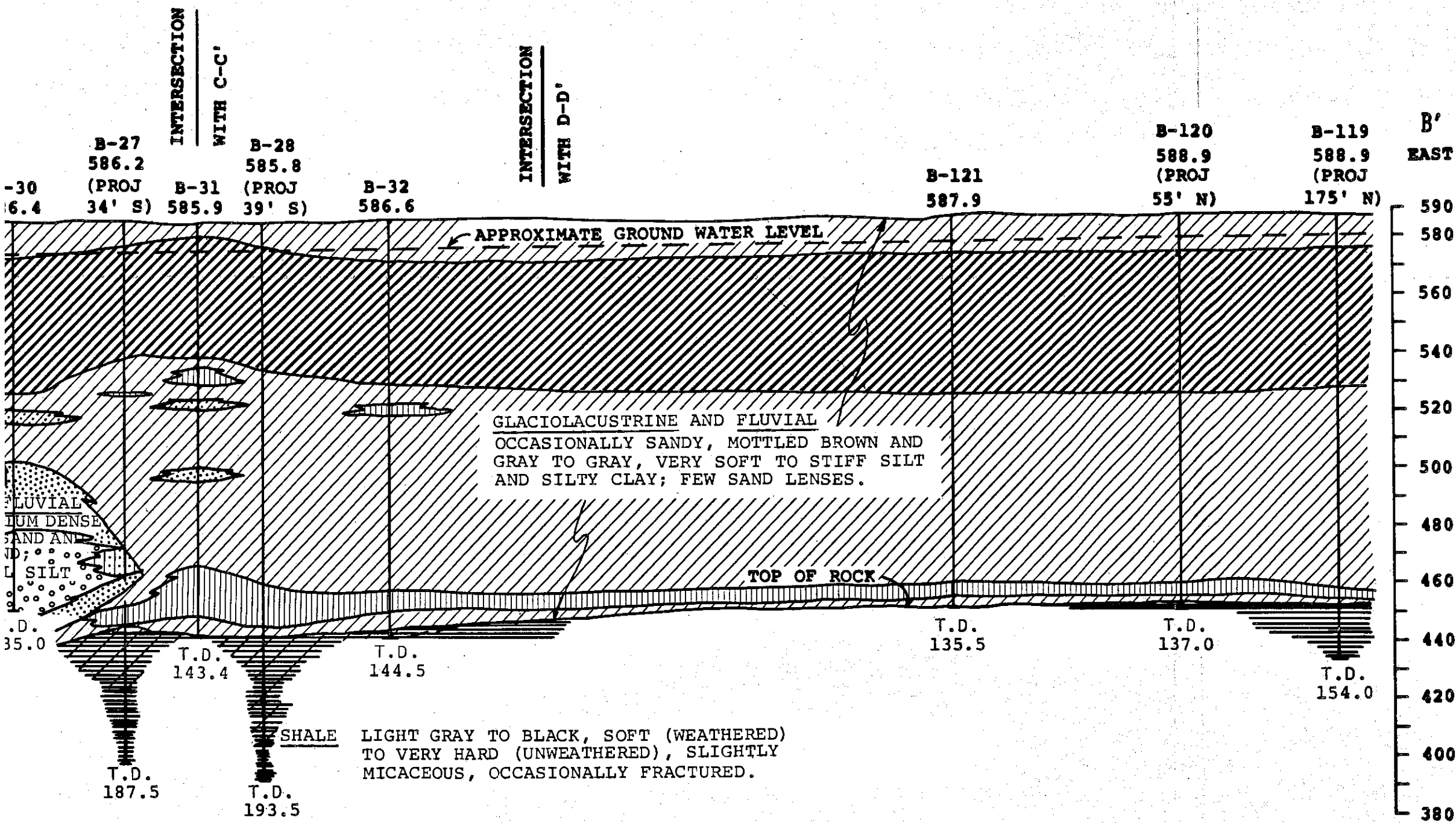
B-187 Bechtel borings (1973-1974)
T.D. Total depth drilled (ft)



NOTES:

- 1.) For location of section see Figure 3.
- 2.) For variation of water table see Section 4.1.3.
- 3.) For boring logs see Appendix B.
- 4.) For Geologic description of site see Section 4.1.2.

BECHTEL ANN ARBOR			
BELLE RIVER PLANT UNIT 1 & 2			
SUBSURFACE PROFILE SECTION A-A'			
	JOB NO. 10539	DRAWING NO. FIGURE 9	REV. ○



EXPLANATION

B-187 Bechtel borings (1973-1974)
T.D. Total depth drilled (ft)



PLANT AREA - UNITS 1 & 2 COAL STORAGE AREA

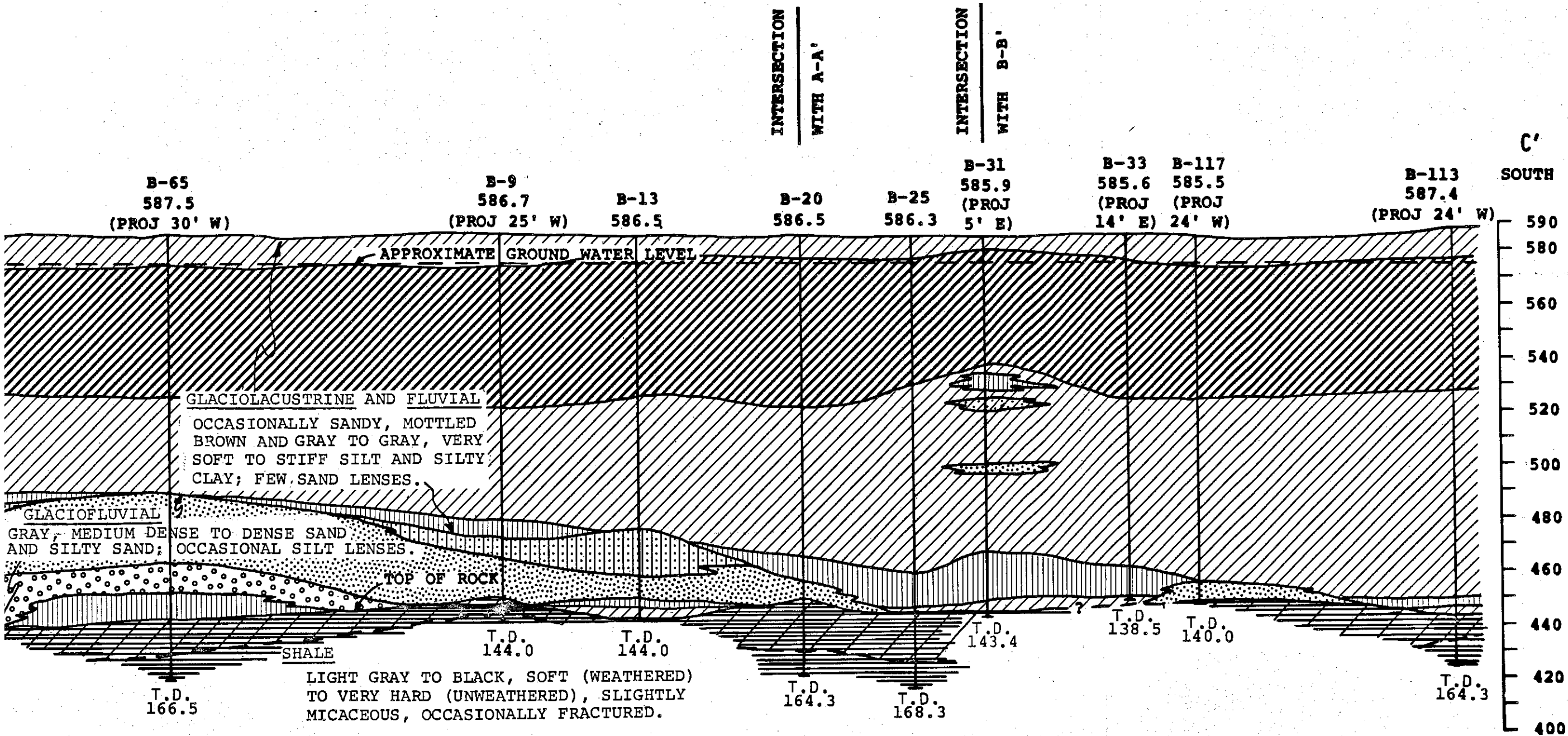
LEGEND

	Sand (SW)		Silty Sand (SM)
	Silt (ML)		Shale (weathered)
	Clayey Sand (SC)		Shale (unweathered)

NOTES:

- 1.) For location of section see Figure 3.
- 2.) For variation of water table see Section 4.1.3.
- 3.) For boring logs see Appendix B.
- 4.) For Geologic description of site see Section 4.1.2.

BECHTEL ANN ARBOR			
BELLE RIVER PLANT UNIT 1 & 2			
SUBSURFACE PROFILE SECTION B-B'			
	JOB NO.	DRAWING NO.	REV.
	10539	FIGURE 9	○



PLANT AREA - UNIT I AND SWITCHYARD

EXPLANATION

- Silt (ML)
- Clayey Sand (SC)
- Silty Sand (SM)
- Shale (weathered)
- Shale (unweathered)

B-187 Bechtel borings (1973-1974)
T.D. Total depth drilled (ft)

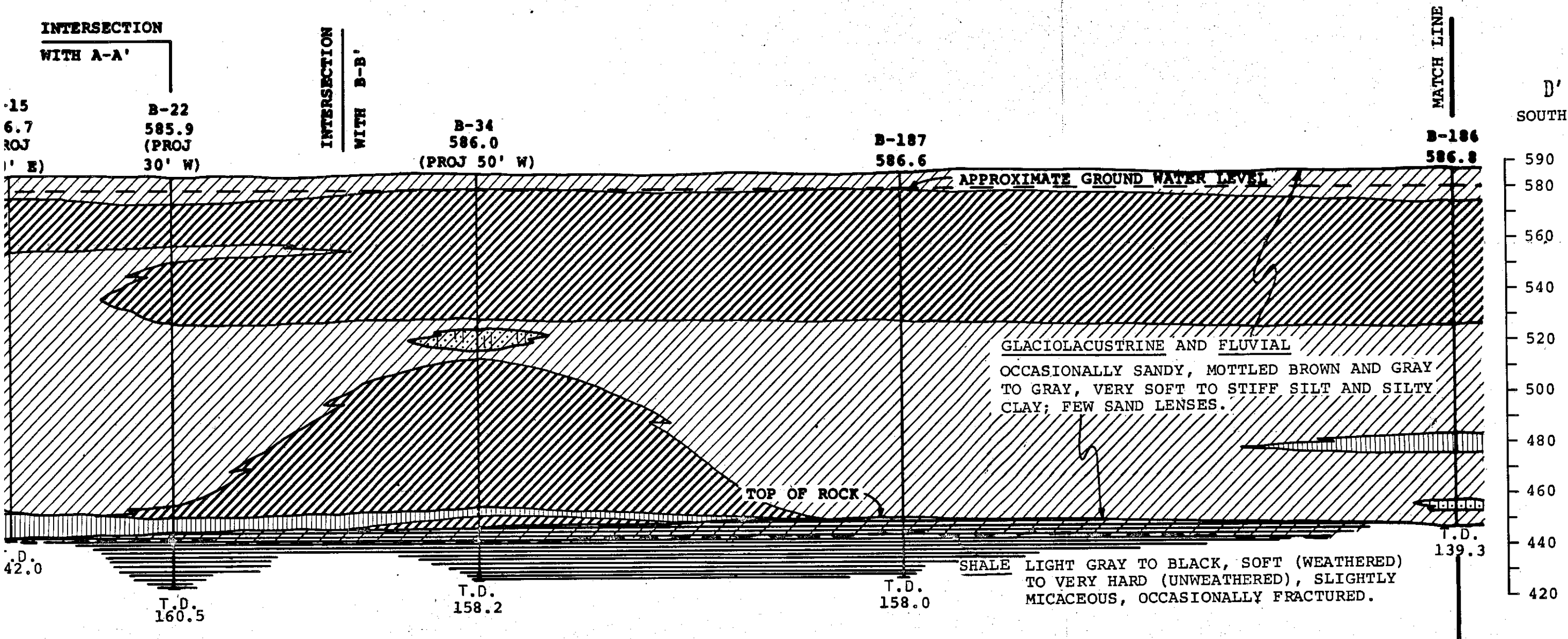


SCALE IN FEET

NOTES:

- 1.) For location of section see Figure 3.
- 2.) For variation of water table see Section 4.1.3.
- 3.) For boring logs see Appendix B.
- 4.) For Geologic description of site see Section 4.1.3.

BECHTEL ANN ARBOR			
BELLE RIVER PLANT UNIT 1 & 2			
SUBSURFACE PROFILE SECTION C-C'			
BECHTEL	JOB NO.	DRAWING NO.	REV.
	10539	FIGURE 9	0



PLANT AREA AND COAL HANDLING CONVEYOR SYSTEM

Shale (weathered)

Shale (unweathered)

EXPLANATION

B-187 Bechtel borings (1973-1974)

T.D. Total depth drilled (ft)

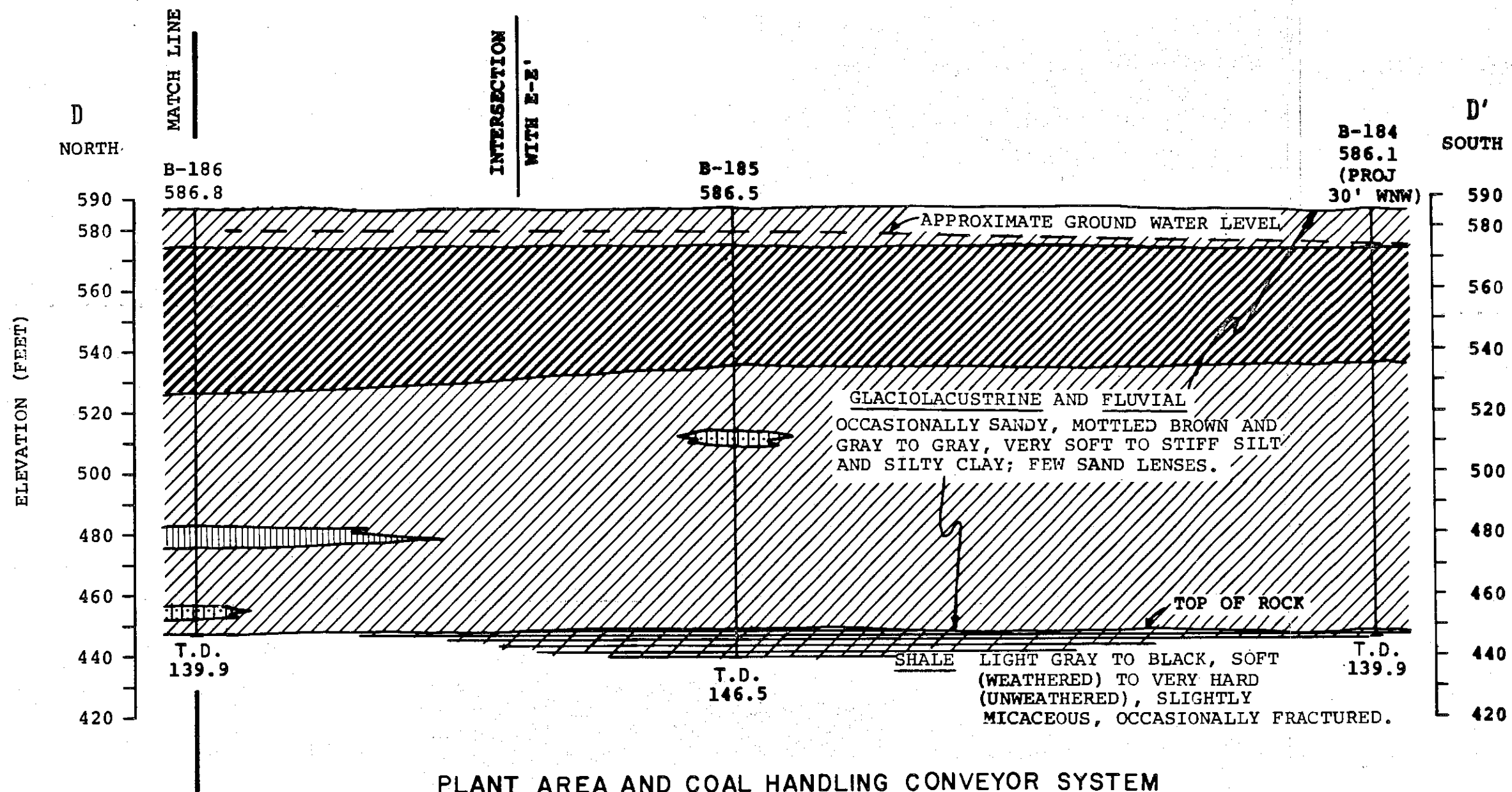
0 100 200 400 600

SCALE IN FEET

NOTES:

- 1.) For location of section see Figure 3.
- 2.) For variation of water table see Section 4.1.3.
- 3.) For boring logs see Appendix B.
- 4.) For Geologic description of site see Section 4.1.2.

BECHTEL			
ANN ARBOR			
BELLE RIVER PLANT			
UNIT 1 & 2			
SUBSURFACE PROFILE			
SECTION D-D'			
SHEET 1 OF 2			
JOB NO.	DRAWING NO.	REV.	
10539	FIGURE 9	O	



LEGEND

- Clay (CL)
- Clay (CH)
- Silt (ML)
- Silty Sand (SM)
- Shale (weathered)

EXPLANATION

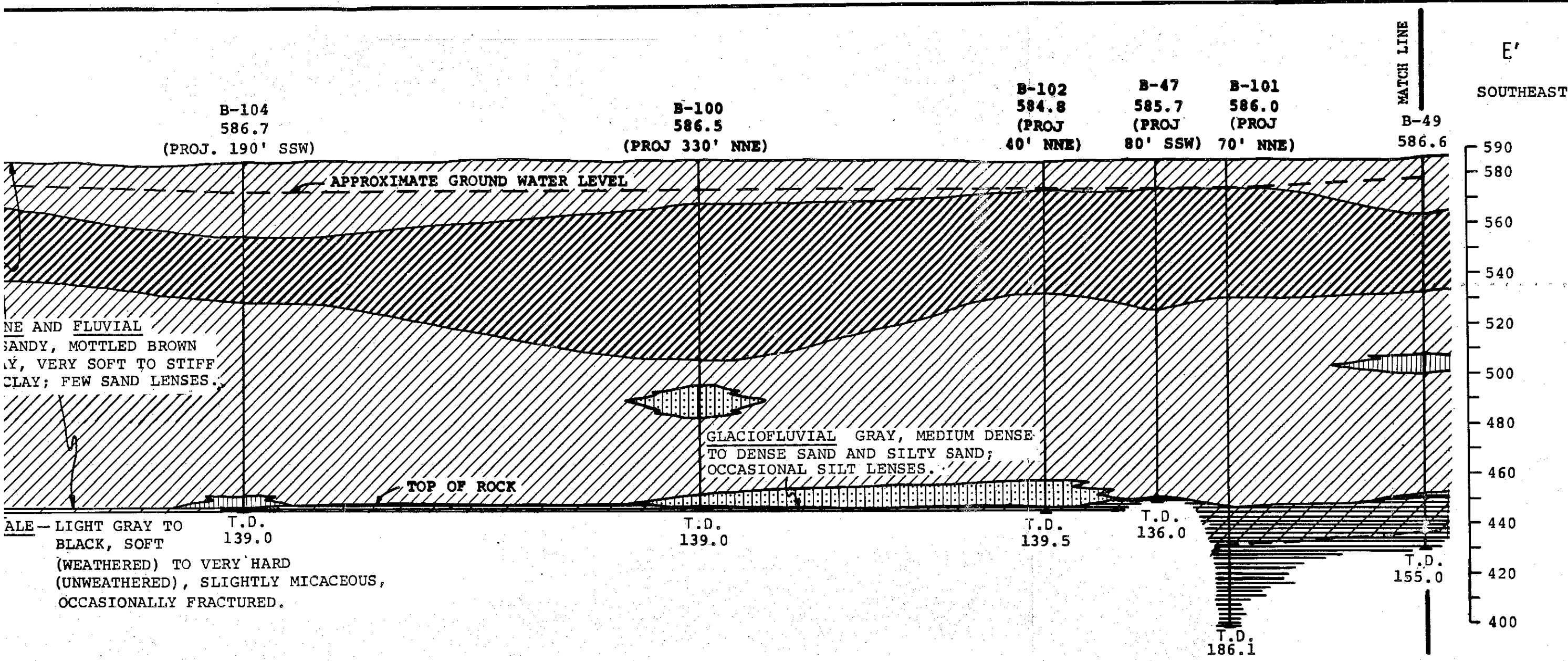
- B-187 Bechtel borings (1973-1974)
- T.D. Total depth drilled (ft)

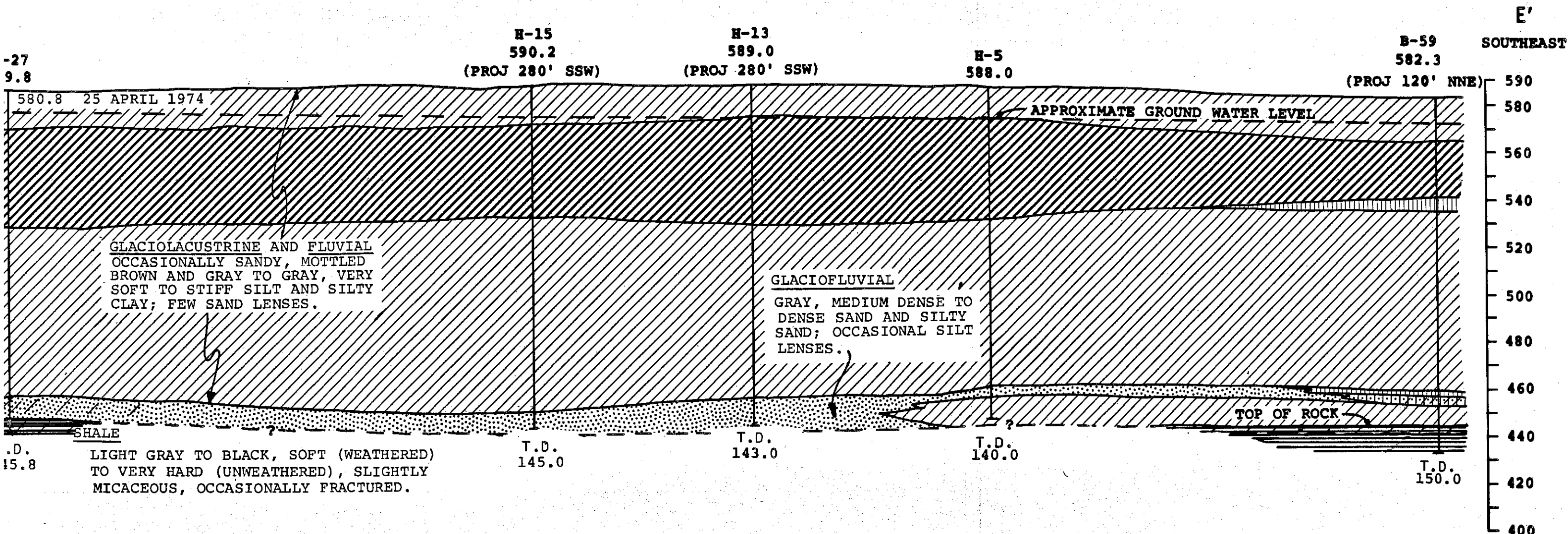


NOTES:

- 1.) For location of section see Figure 3.
- 2.) For variation of water table see Section 4.1.3.
- 3.) For boring logs see Appendix B.
- 4.) For Geologic description of site see Section 4.1.2.

BECHTEL ANN ARBOR			
BELLE RIVER PLANT UNIT 1 & 2			
SUBSURFACE PROFILE SECTION D-D' SHEET 2 OF 2			
BECHTEL	JOB NO.	DRAWING NO.	REV.
	10539	FIGURE 9	○





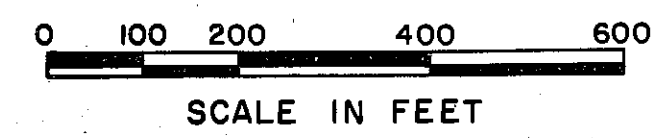
COAL HANDLING CONVEYOR SYSTEM AND COAL STORAGE AREAS

END

- Clayey Sand (SC)
- Silty Sand (SM)
- Shale (weathered)
- Shale (unweathered)

EXPLANATION

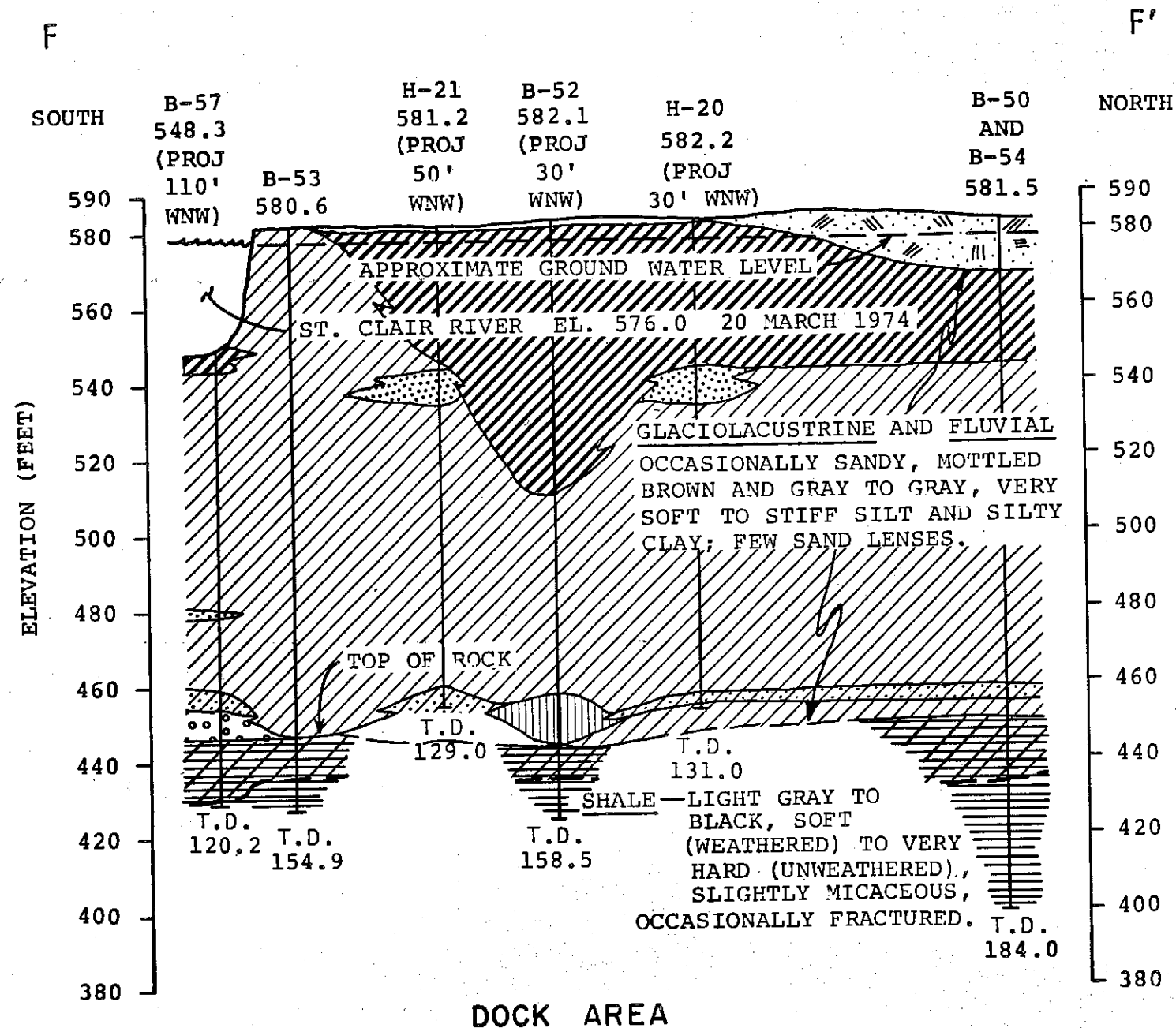
- B-187 Bechtel borings (1973-1974)
- H-15 Housel borings (1950-1967)
- T.D. Total depth drilled (ft)



NOTES:

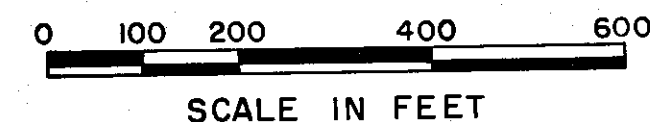
- 1.) For location of section see Figure 3.
- 2.) For variation of water table see Section 4.1.3.
- 3.) For boring logs see Appendix B.
- 4.) For Geologic description of site see Section 4.1.2.

BECHTEL ANN ARBOR		
BELLE RIVER PLANT UNIT 1 & 2		
SUBSURFACE PROFILE SECTION E-E' SHEET 2 OF 2		
	JOB NO. 10539	DRAWING NO. FIGURE 9
		REV. O



LEGEND

- Clay (CL)
- Clay (CH)
- Sand (SP)
- Sand (SW)
- Silt (ML)
- Clayey Sand (SC)
- Fill
- Shale (weathered)
- Shale (unweathered)




NOTES:

- 1.) For location of section see Figure 3.
- 2.) For variation of water table see Section 4.1.3.
- 3.) For boring logs see Appendix B.
- 4.) For Geologic description of site see Section 4.1.2.

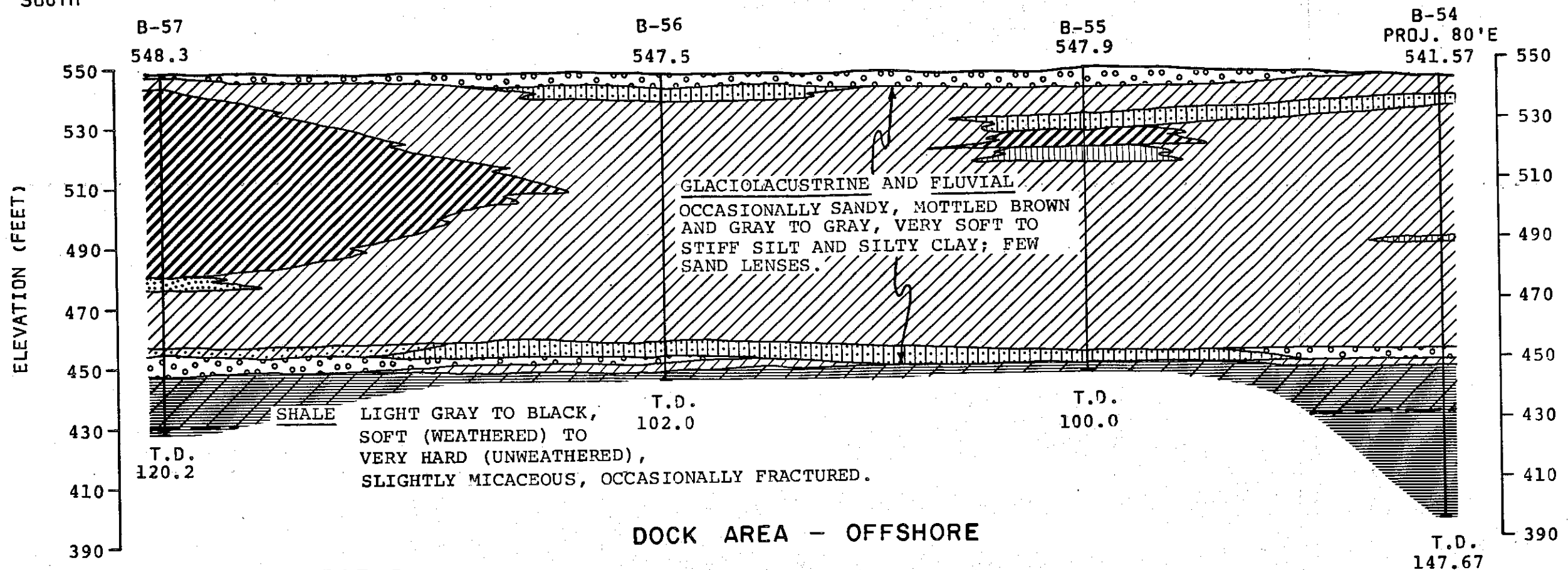
EXPLANATION

- B-187 Bechtel borings (1973-1974)
- H-15 Housel borings (1950-1967)
- T.D. Total depth drilled (ft)

BECHTEL ANN ARBOR			
BELLE RIVER PLANT UNIT 1 & 2			
SUBSURFACE PROFILE SECTION F-F'			
	JOB NO.	DRAWING NO.	REV.
	10539	FIGURE 9	0

6
SOUTH

G'
NORTH



LEGEND

	Clay (CL)		Silt (ML)
	Clay (CH)		Clayey Sand (SC)
	Sand (SP)		Silty Sand (SM)
	Sand (SW)		Shale (weathered)
	Shale (unweathered)		

EXPLANATION

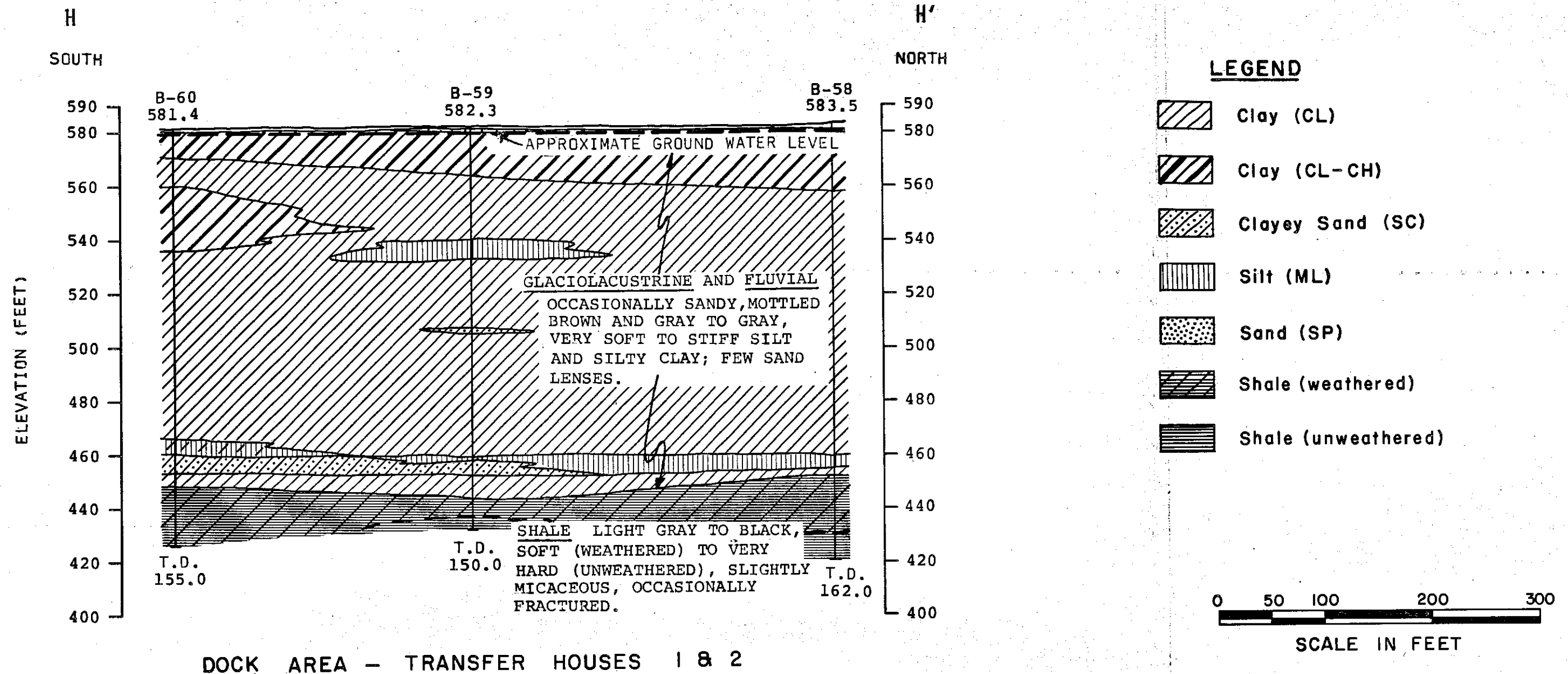
B-187 Bechtel borings (1973-1974)
T.D. Total depth drilled (ft)

NOTES:

- 1.) For location of section see Figure 3.
- 2.) Depth of the St. Clair River water is approximately 31 feet throughout this section.
- 3.) For boring logs see Appendix B.
- 4.) For Geologic description of site see Section 4.1.2.



BECHTEL ANN ARBOR		
BELLE RIVER PLANT UNIT 1 & 2		
SUBSURFACE PROFILE SECTION G-G'		
	JOB NO. 10539	DRAWING NO. FIGURE 9
		REV. ○



EXPLANATION

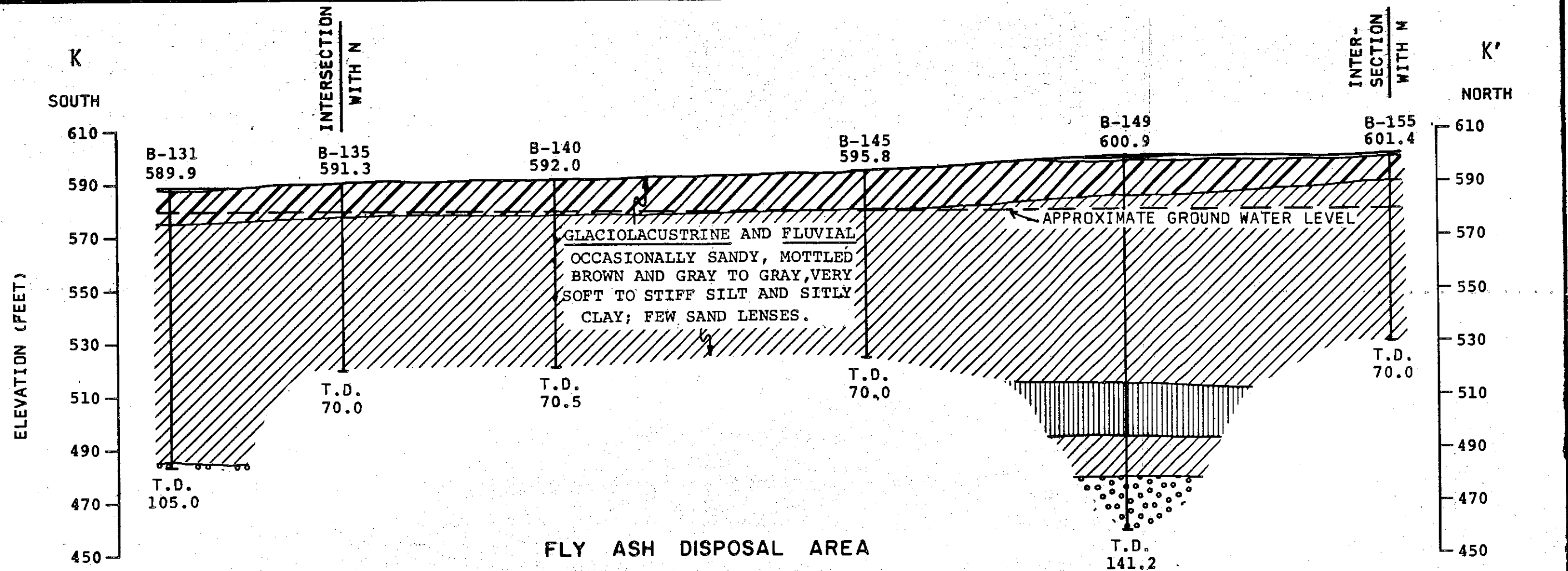
B-187 Bechtel borings (1973-1974)





T.D. Total depth drilled (ft)

NOTES:

- 1.) For location of section see Figure 3.
- 2.) For variation of water table see Section 4.1.3.
- 3.) For boring logs see Appendix B.
- 4.) For Geologic description of site see Section 4.1.2.

BECHTEL ANN ARBOR			
BELLE RIVER PLANT UNIT 1 & 2			
SUBSURFACE PROFILE SECTION H-H'			
	JOB NO.	DRAWING NO.	REV.
	10539	FIGURE 9	0




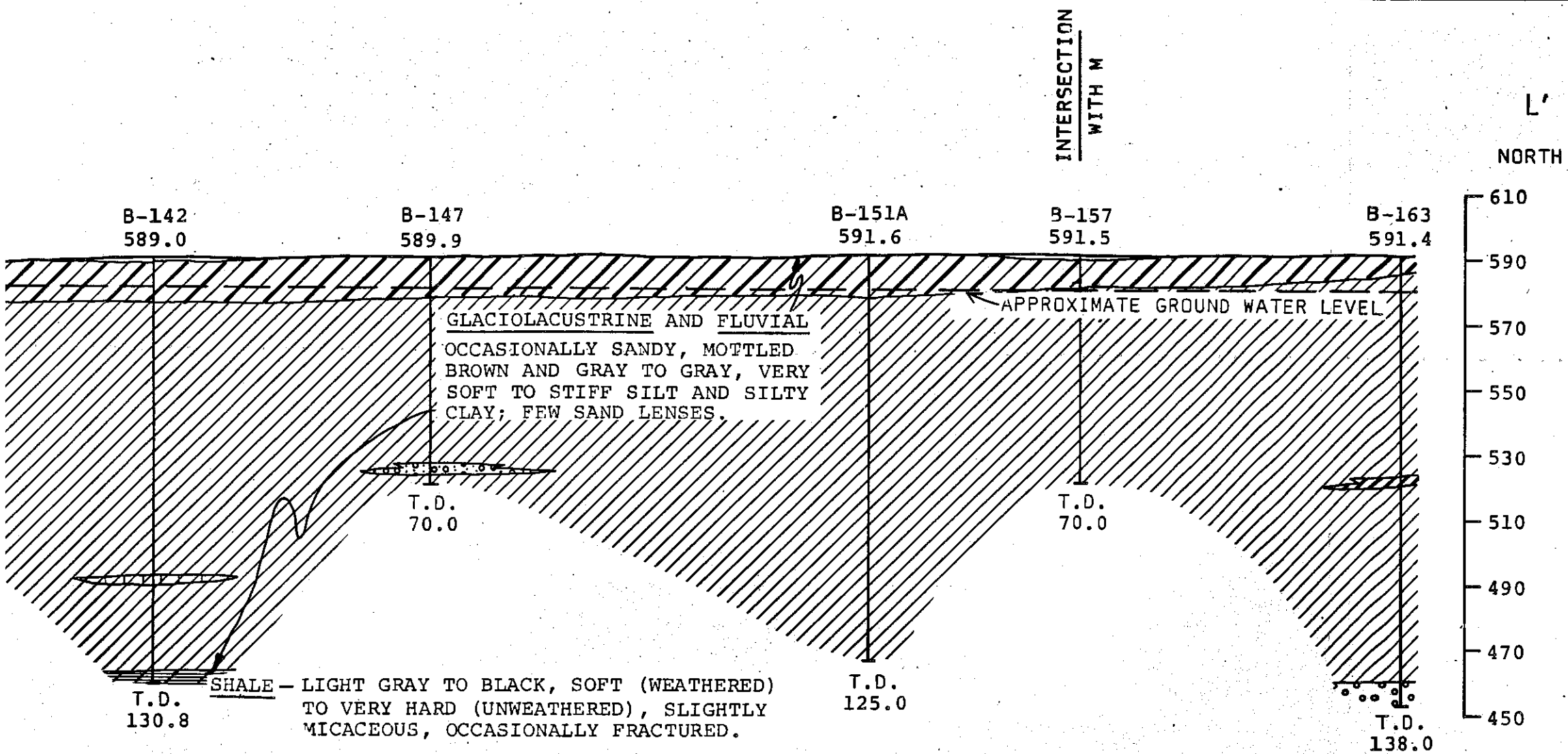
- LEGEND**
-  Clay (CL)
 -  Clay (CL-CH)
 -  Sand (SW)
 -  Silt (ML)

B-187 Bechtel borings (1973-1974)

T.D. Total depth drilled (ft)

- NOTES:**
- 1.) For location of section see Figure 4.
 - 2.) For variation of water table see Section 4.1.3.
 - 3.) For boring logs see Appendix B.
 - 4.) For Geologic description of site see Section 4.1.2.

BECHTEL ANN ARBOR			
BELLE RIVER PLANT UNIT 1 & 2			
SUBSURFACE PROFILE SECTION K-K'			
	JOB NO. 10539	DRAWING NO. FIGURE 9	REV. 0



NOTES:

- 1.) For location of section see Figure 4.
- 2.) For variation of water table see Section 4.1.3.
- 3.) For boring logs see Appendix B.
- 4.) For Geologic description of site see Section 4.1.2.



GEND

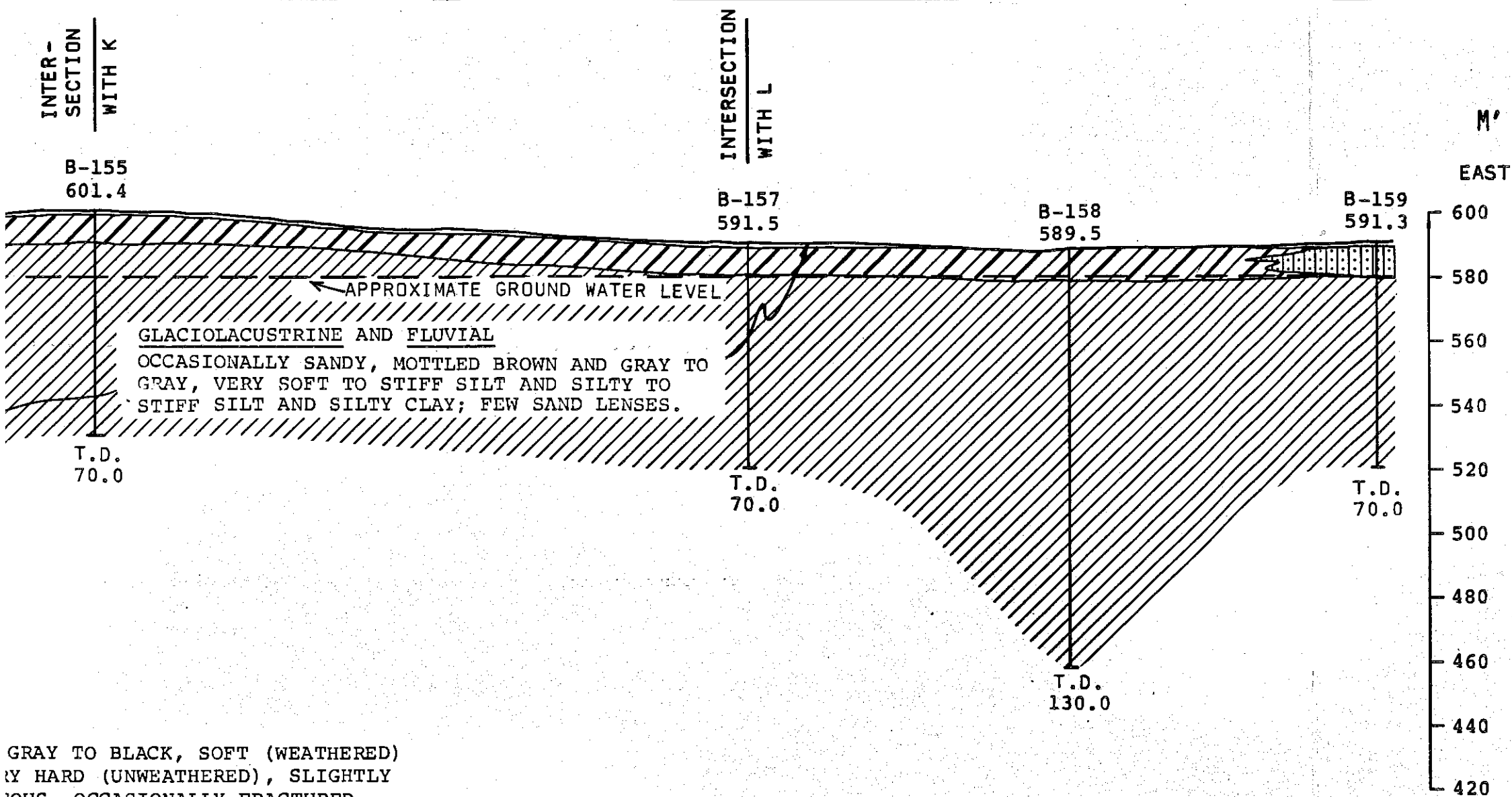
EXPLANATION

- Sand (SW)
- Silt (ML)
- Shale (weathered)

B-187 Bechtel borings (1973-1974)

T.D. Total depth drilled (ft)

BECHTEL ANN ARBOR			
BELLE RIVER PLANT UNIT 1 & 2			
SUBSURFACE PROFILE SECTION L-L'			
	JOB NO.	DRAWING NO.	REV.
	10539	FIGURE 9	○



NOTES:

- 1.) For location of section see Figure 4.
- 2.) For variation of water table see Section 4.1.3.
- 3.) For boring logs see Appendix B.
- 4.) For Geologic description of site see Section 4.1.2.



GRAY TO BLACK, SOFT (WEATHERED)
BY HARD (UNWEATHERED), SLIGHTLY
MOUS, OCCASIONALLY FRACTURED.

FLY ASH DISPOSAL AREA

LEGEND

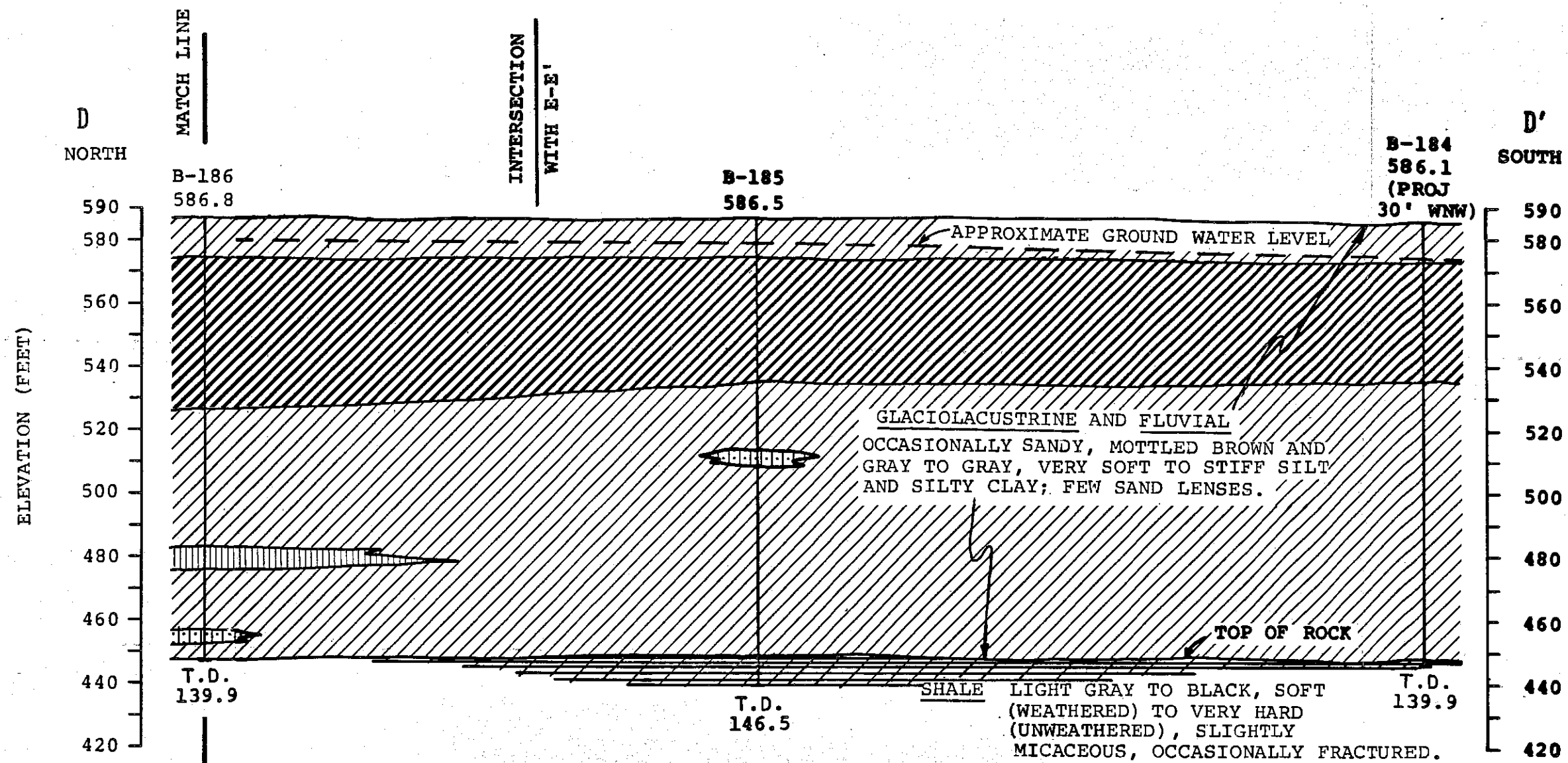
ay (CL)		Silt (ML)
ay (CH)		Silty Sand (SM)
ay (CL-CH)		Clayey Sand (SC)
ind (SP)		Shale (weathered)

EXPLANATION

B-187 Bechtel borings (1973-1974)






T.D. Total depth drilled (ft)

BECHTEL ANN ARBOR			
BELLE RIVER PLANT UNIT 1 & 2			
SUBSURFACE PROFILE SECTION M-M'			
	JOB NO.	DRAWING NO.	REV.
	10539	FIGURE 9	0



PLANT AREA AND COAL HANDLING CONVEYOR SYSTEM

LEGEND

-  Clay (CL)
-  Clay (CH)
-  Silt (ML)
-  Silty Sand (SM)
-  Shale (weathered)


EXPLANATION

- B-187 Bechtel borings (1973-1974)
- T.D. Total depth drilled (ft)



NOTES:

- 1.) For location of section see Figure 3.
- 2.) For variation of water table see Section 4.1.3.
- 3.) For boring logs see Appendix B.
- 4.) For Geologic description of site see Section 4.1.2.

BECHTEL		
ANN ARBOR		
BELLE RIVER PLANT		
UNIT 1 & 2		
SUBSURFACE PROFILE		
SECTION D-D'		
SHEET 2 OF 2		
	JOB NO.	DRAWING NO.
	10539	FIGURE 9
		REV.
		○



EXPLANATION

- Basal sand thickness (ft)
- Boring number (present investigation)
- Basal sand thickness (ft)
- Boring number (previous investigations for St. Clair Plant)

NOTE:

Detail A (plant area) enlarged for clarity, to twice graphic scale shown below.



0 200 400 800 1200

SCALE IN FEET

CONTOUR INTERVAL = 10 FT

BECHTEL
ANN ARBOR

BELLE RIVER PLANT
UNIT 1 & 2

BASAL SAND THICKNESS
CONTOUR MAP



JOB NO.

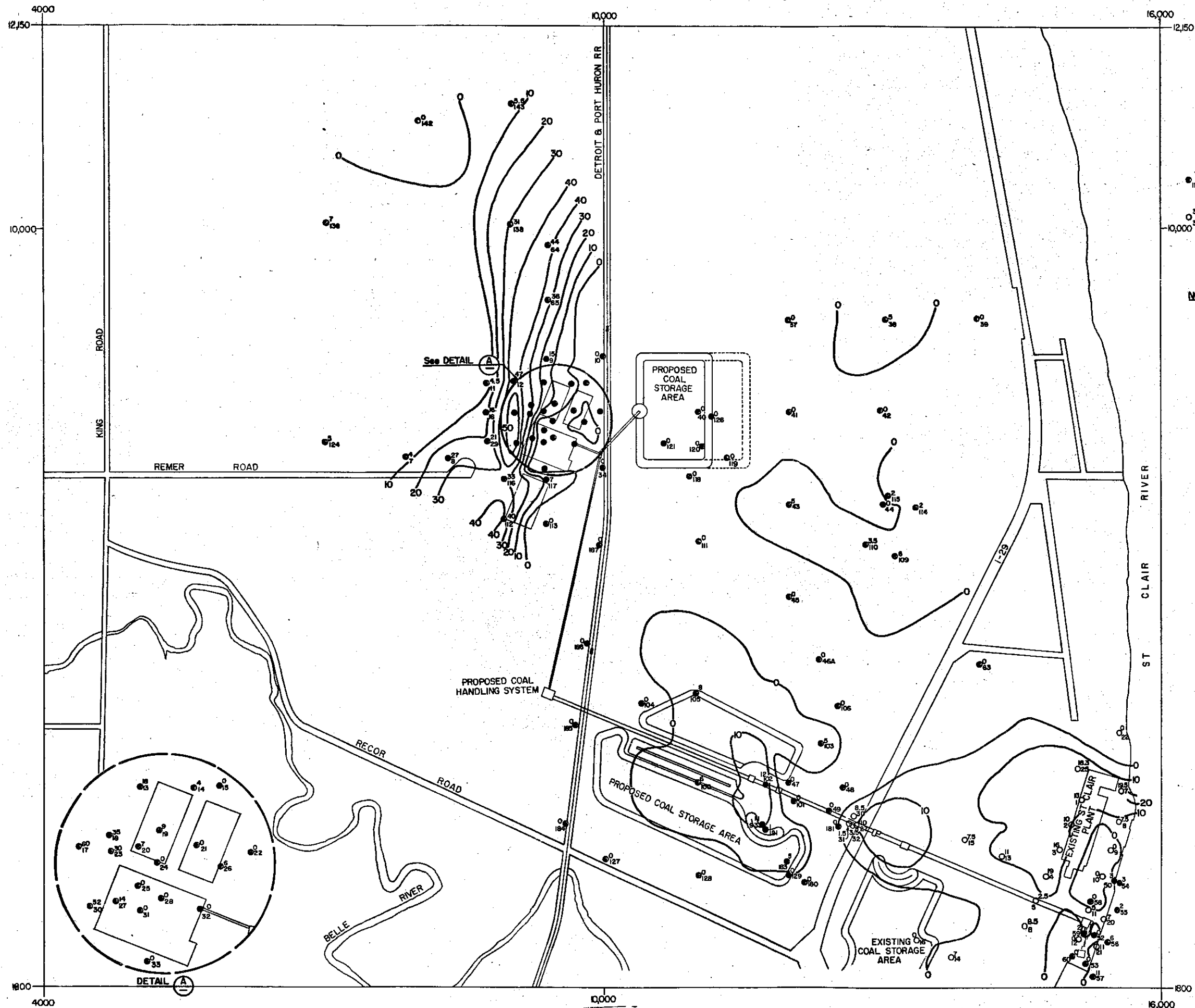
10539

DRAWING NO.

FIGURE 10

REV.

1



EXPLANATION

- Basal sand thickness (ft)
- Boring number (present investigation)
- Basal sand thickness (ft)
- Boring number (previous investigations for St. Clair Plant)

NOTE:

Detail A (plant area) enlarged for clarity, to twice graphic scale shown below.



0 200 400 800 1200

SCALE IN FEET

CONTOUR INTERVAL = 10 FT

BECHTEL
ANN ARBOR

BELLE RIVER PLANT
UNIT 1 & 2

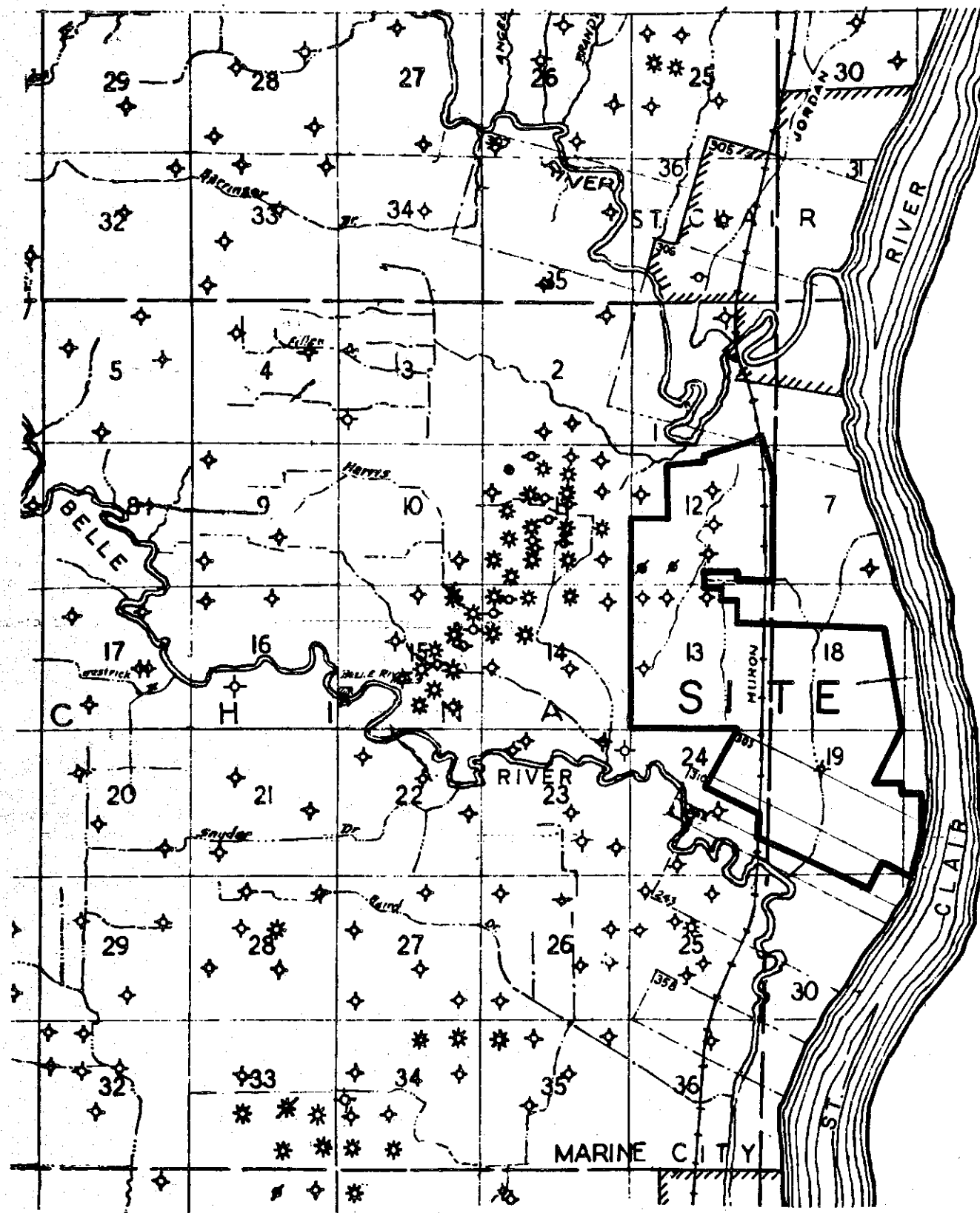
BASAL SAND THICKNESS
CONTOUR MAP



JOB NO.
10539

DRAWING NO.
FIGURE 10

REV.
1



EXPLANATION

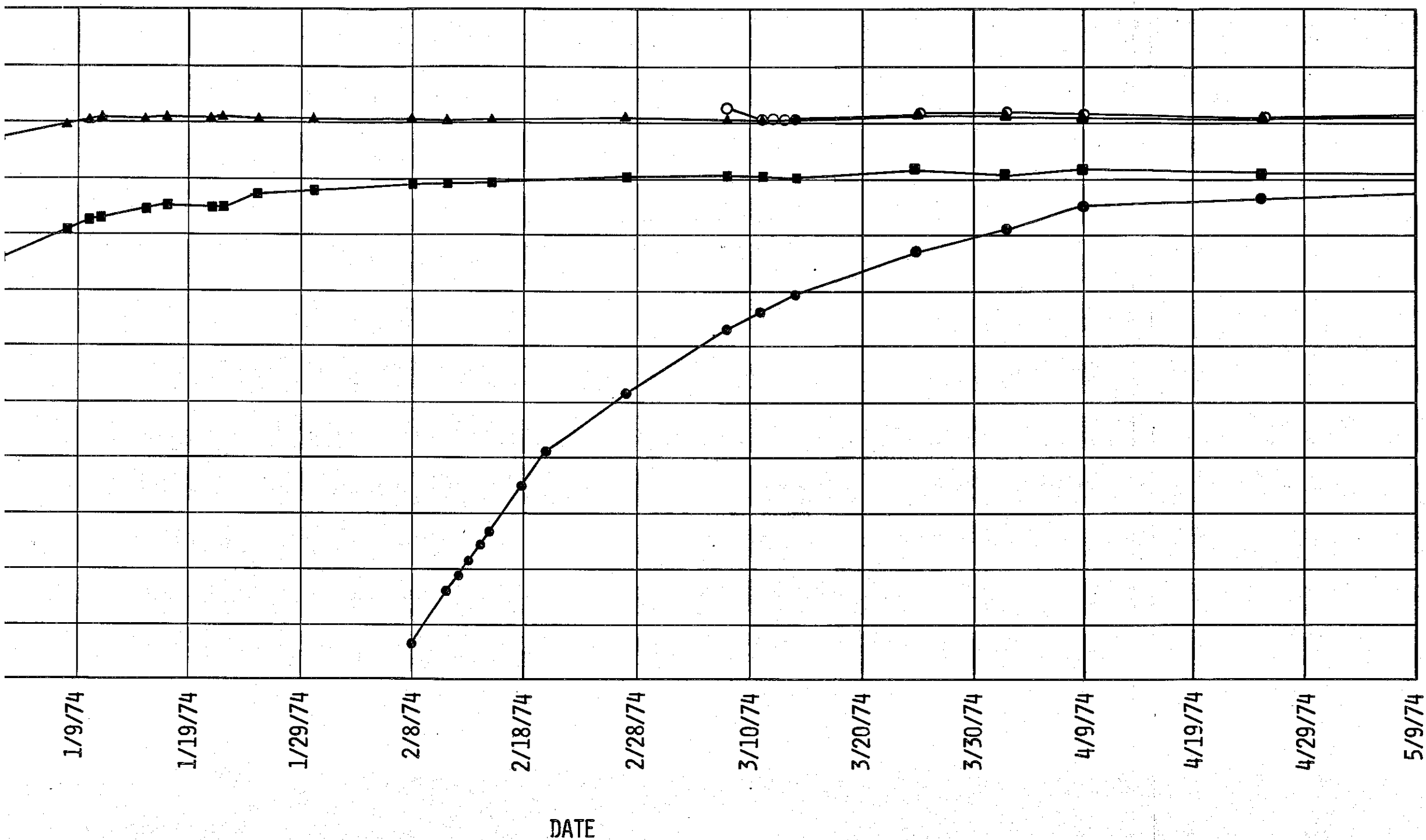
- Oil Well
- * Gas Well
- ⬢ Dry Hole
- Other
- ⬢ Abandoned Well

REFERENCE:

Modified from Michigan Geological Survey Oil and Gas Well Map 3689A, St. Clair County.



BECHTEL ANN ARBOR			
BELLE RIVER PLANT UNIT 1 & 2			
LOCATION OF OIL AND GAS WELLS			
BECHTEL	JOB NO.	DRAWING NO.	REV.
	10539	FIGURE 12	○



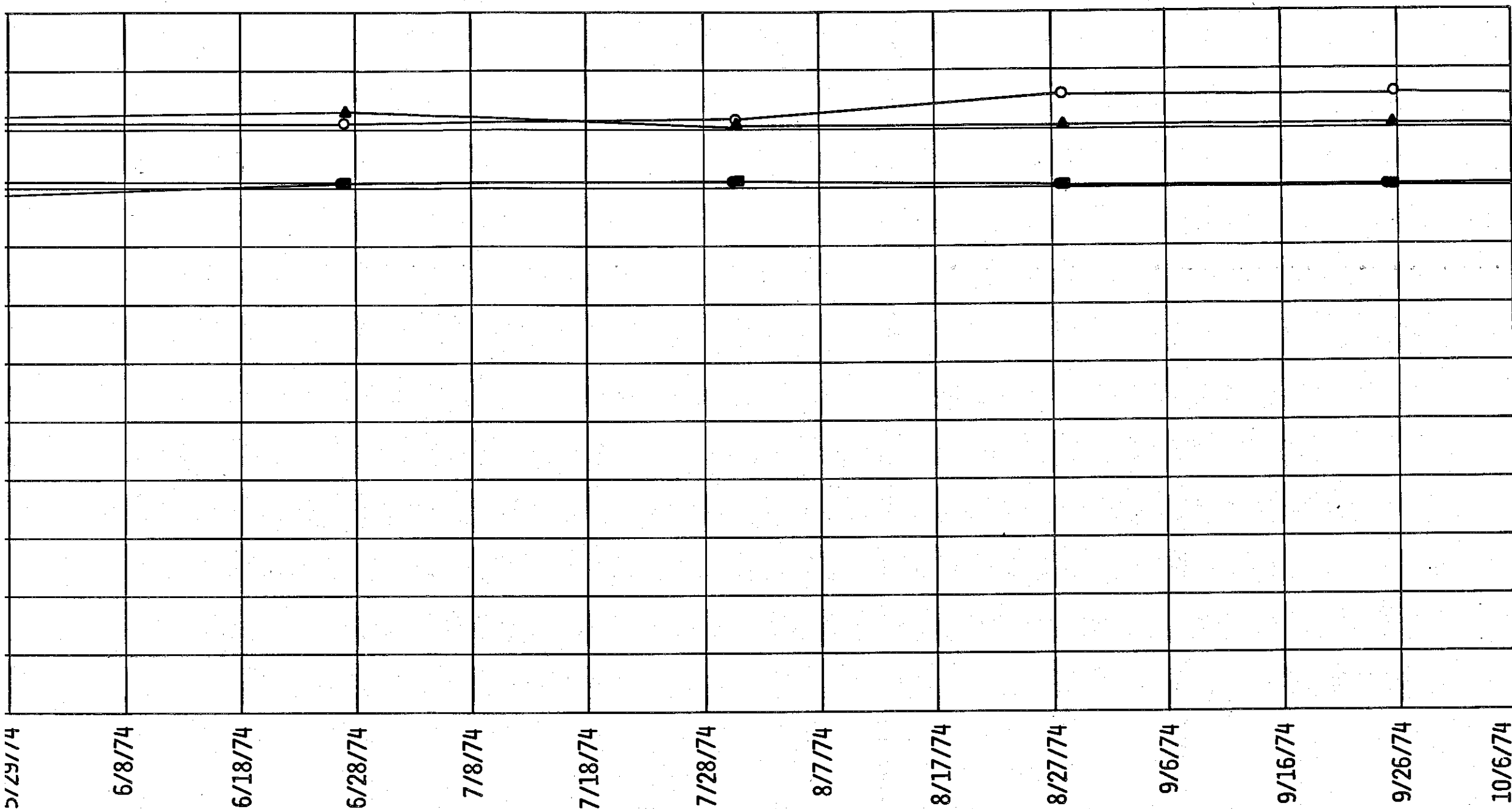
EXPLANATION

- Observation Well 7, bottom of screen at Elevation 450.5
- Observation Well 24, bottom of screen at Elevation 452.3
- ▲ Observation Well 40, bottom of screen at Elevation 509.1
- Observation Well 181, bottom of screen at Elevation 449.3

NOTE:

For location of Observation Wells see Figure 3.

BECHTEL ANN ARBOR			
BELLE RIVER PLANT UNIT 1 & 2			
HYDROGRAPHS OF OBSERVATION WELLS SHEET 1 OF 3			
	JOB NO.	DRAWING NO.	REV.
	10539	FIGURE 14	1



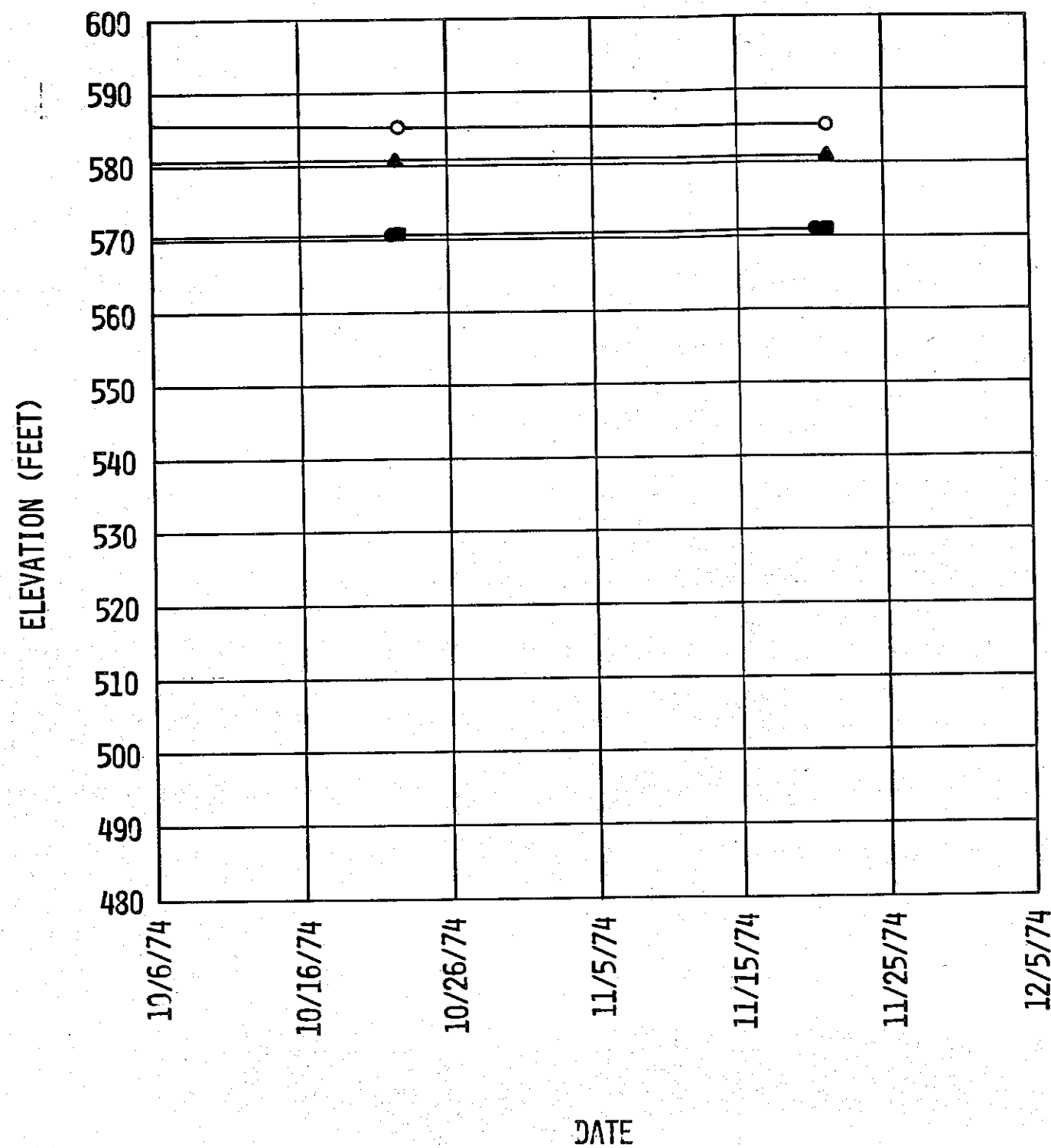
EXPLANATION

- Observation Well 7, bottom of screen at Elevation 450.5
- Observation Well 24, bottom of screen at Elevation 452.3
- ▲ Observation Well 40, bottom of screen at Elevation 509.1
- Observation Well 181, bottom of screen at Elevation 449.3

NOTE

For location of Observation Wells see Figure 3.

BECHTEL ANN ARBOR			
BELLE RIVER PLANT UNIT 1 & 2			
HYDROGRAPHS OF OBSERVATION WELLS SHEET 2 OF 3			
	JOB NO.	DRAWING NO.	REV.
	10539	FIGURE 14	1




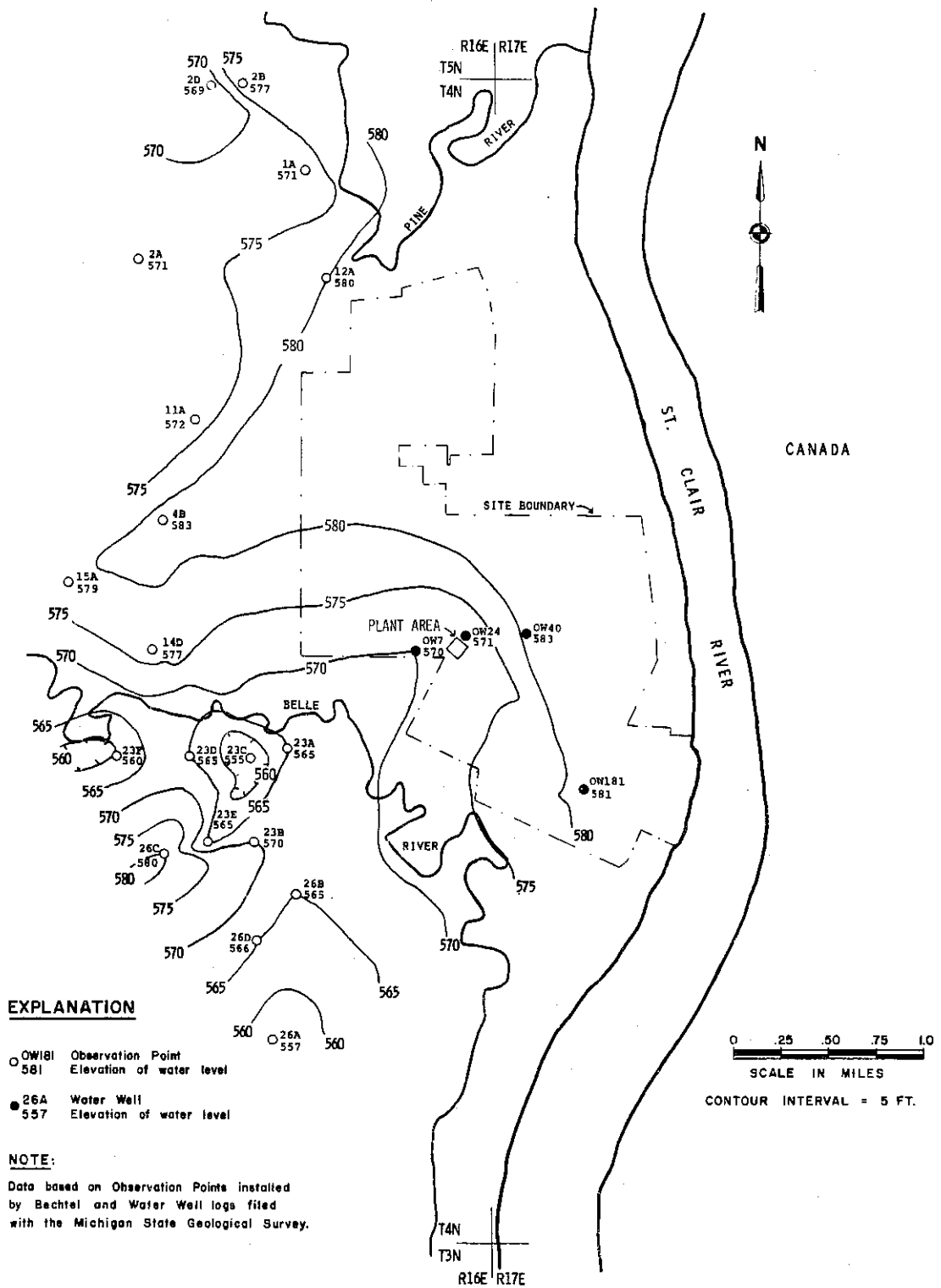
EXPLANATION


- Observation Well 7, bottom of screen at Elevation 450.5
- Observation Well 24, bottom of screen at Elevation 452.3
- ▲ Observation Well 40, bottom of screen at Elevation 509.1
- Observation Well 181, bottom of screen at Elevation 449.3

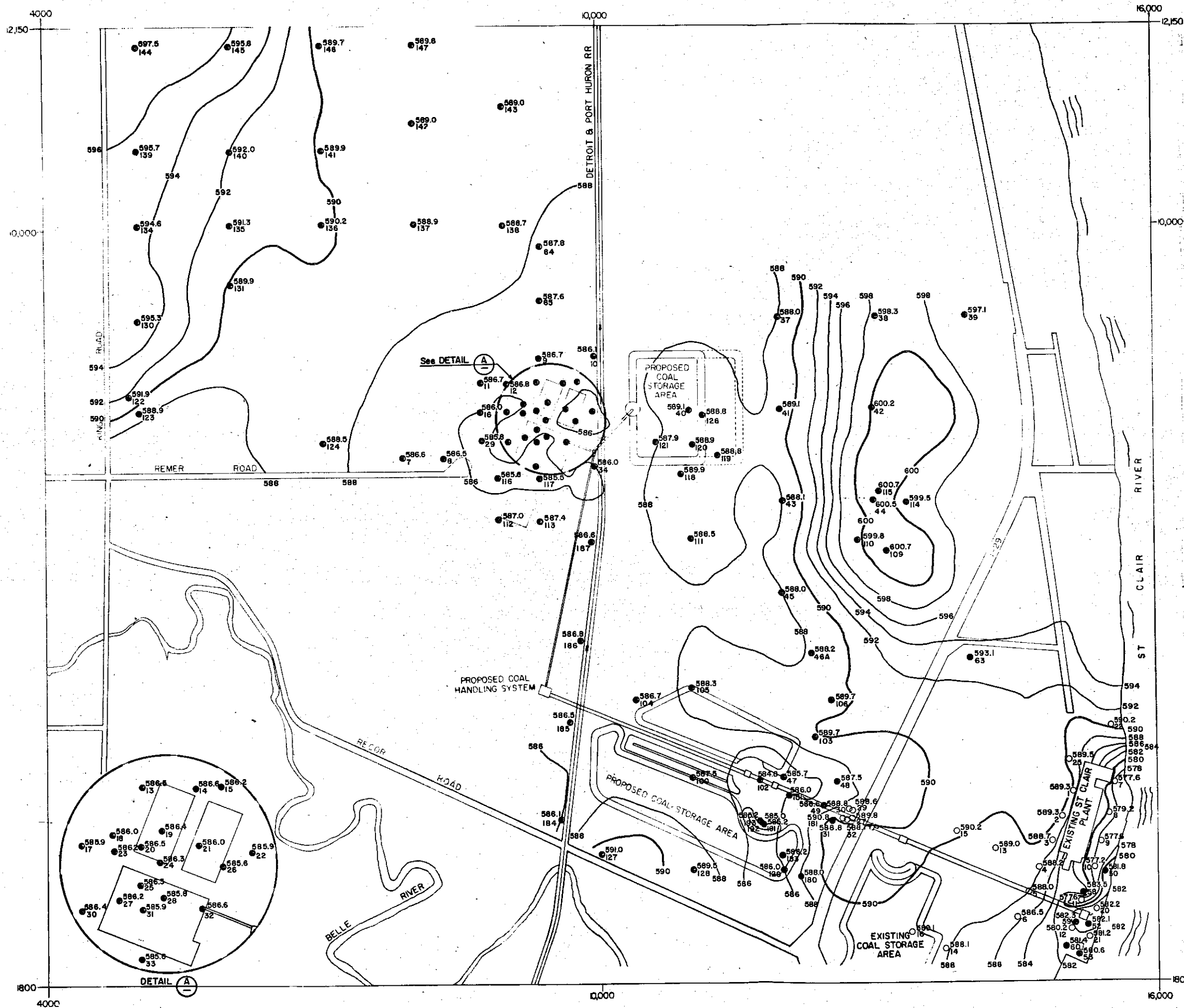
NOTE:

For location of Observation Wells see Figure 3.

BECHTEL ANN ARBOR		
BELLE RIVER PLANT UNIT 1 & 2		
HYDROGRAPHS OF OBSERVATION WELLS SHEET 3 OF 3		
	JOB NO. 10539	DRAWING NO. FIGURE 14
		REV. 1



BECHTEL ANN ARBOR			
BELLE RIVER PLANT UNIT 1 & 2			
GROUND WATER LEVEL CONTOUR MAP			
	JOB NO.	DRAWING NO.	REV.
	10539	FIGURE 15	1



EXPLANATION

- 586.6 Ground surface elevation (ft)
- 187 Boring number (present investigation)
- 588.7 Ground surface elevation (ft)
- 32 Boring number (previous investigations for St Clair plant)

NOTES:

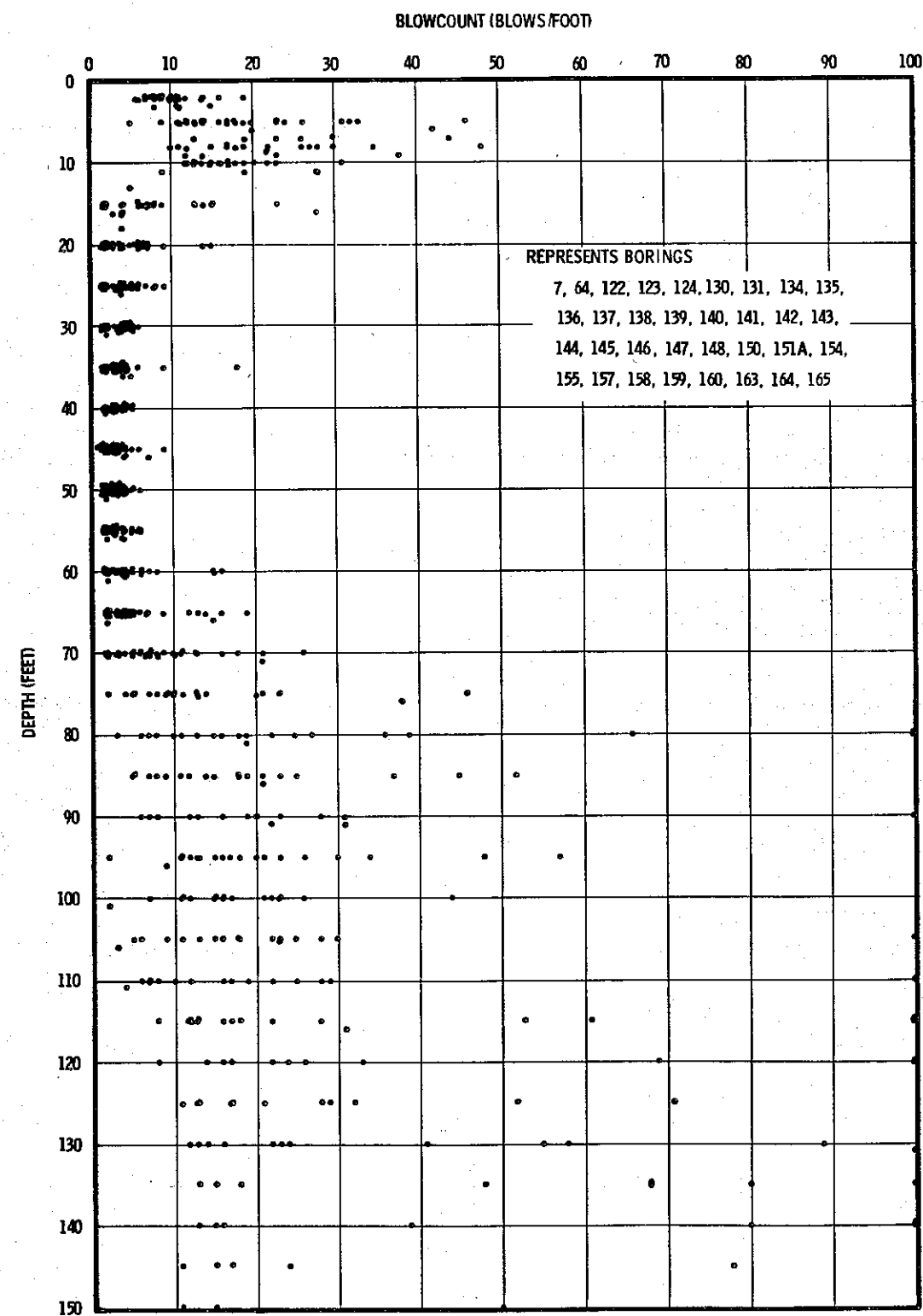
1. Contours generated from drill hole data by McDonnell Douglas Automation Company's SURMAP computer program.
2. Computer interpretation modified manually to accommodate additional data points.
3. Detail A (plant area) enlarged for clarity, to twice graphic scale shown below.



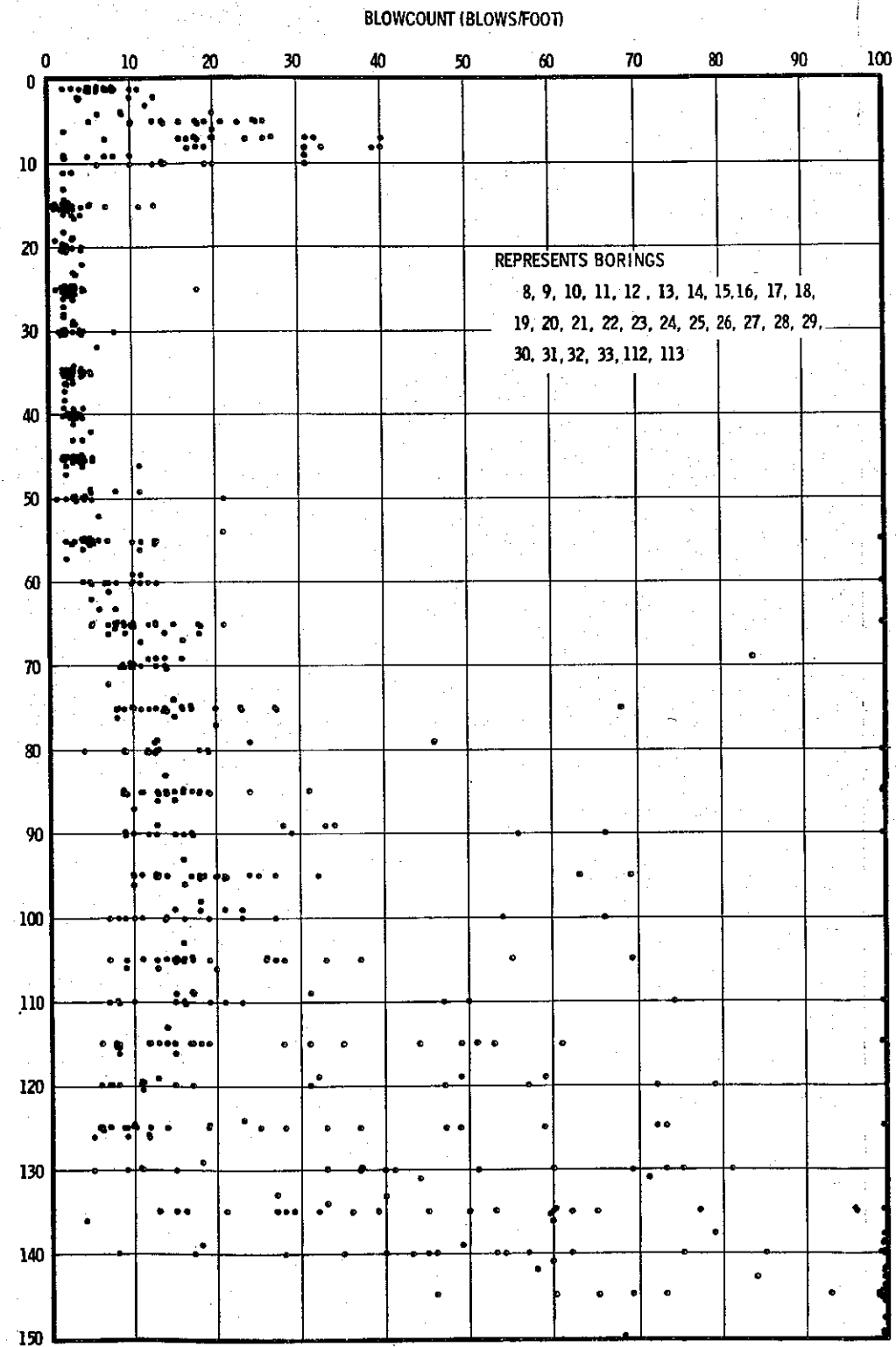
0 200 400 800 1200
SCALE IN FEET

CONTOUR INTERVAL = 2 FT

BECHTEL ANN ARBOR		
BELLE RIVER PLANT UNIT 1 & 2		
GROUND SURFACE CONTOUR MAP		
JOB NO. 10539	DRAWING NO. FIGURE 16	REV. 1

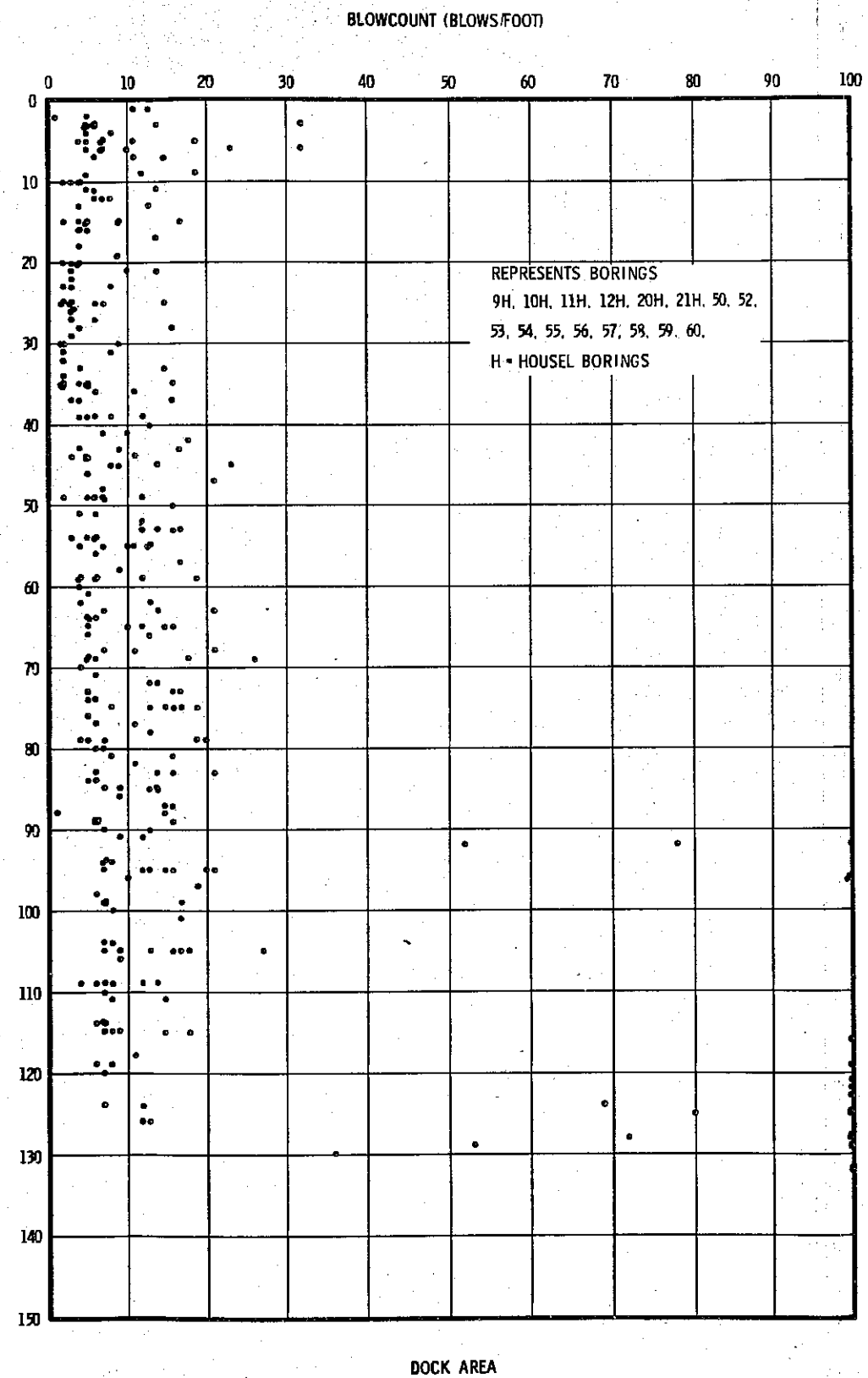
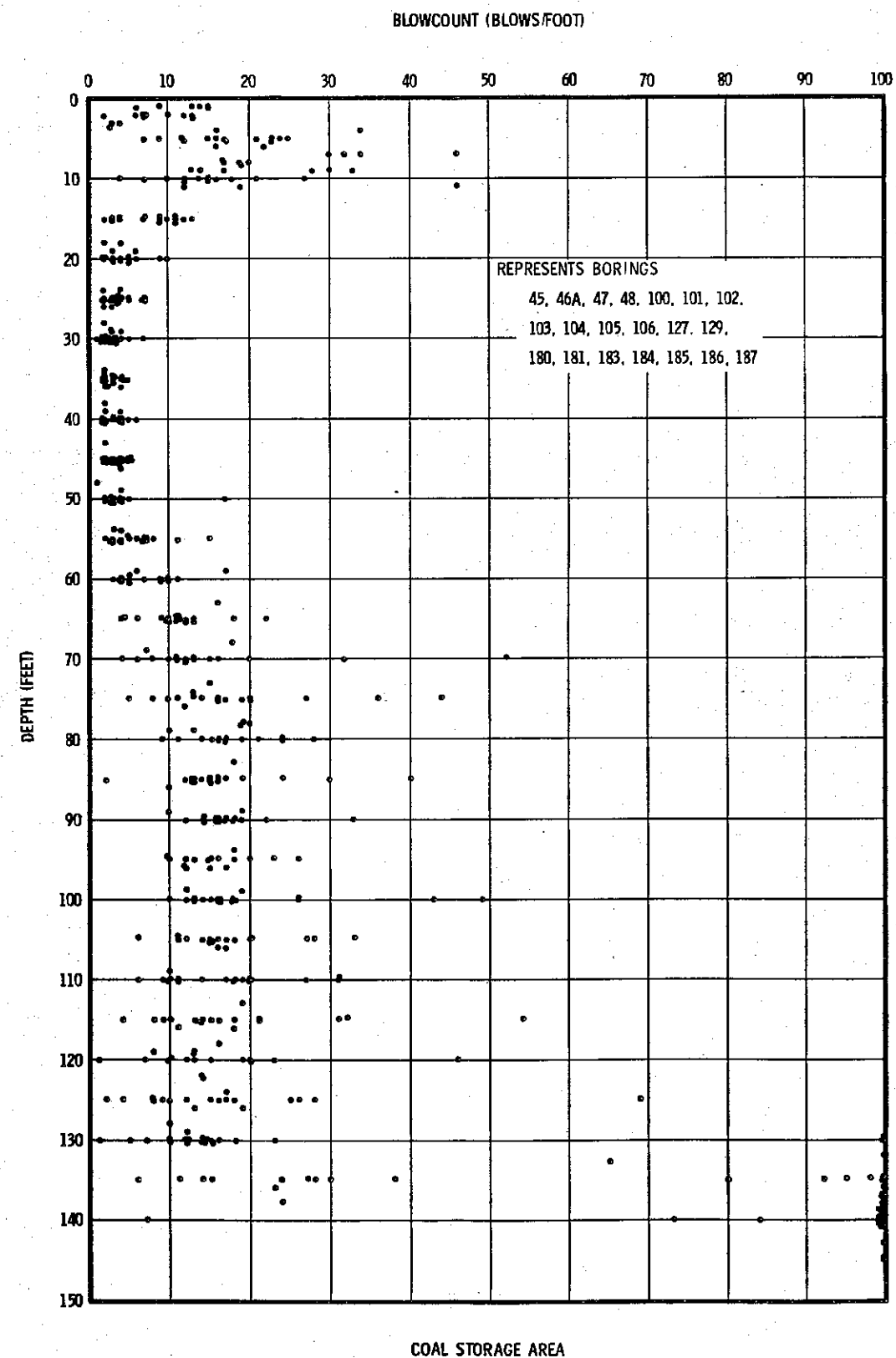


NORTH AREA

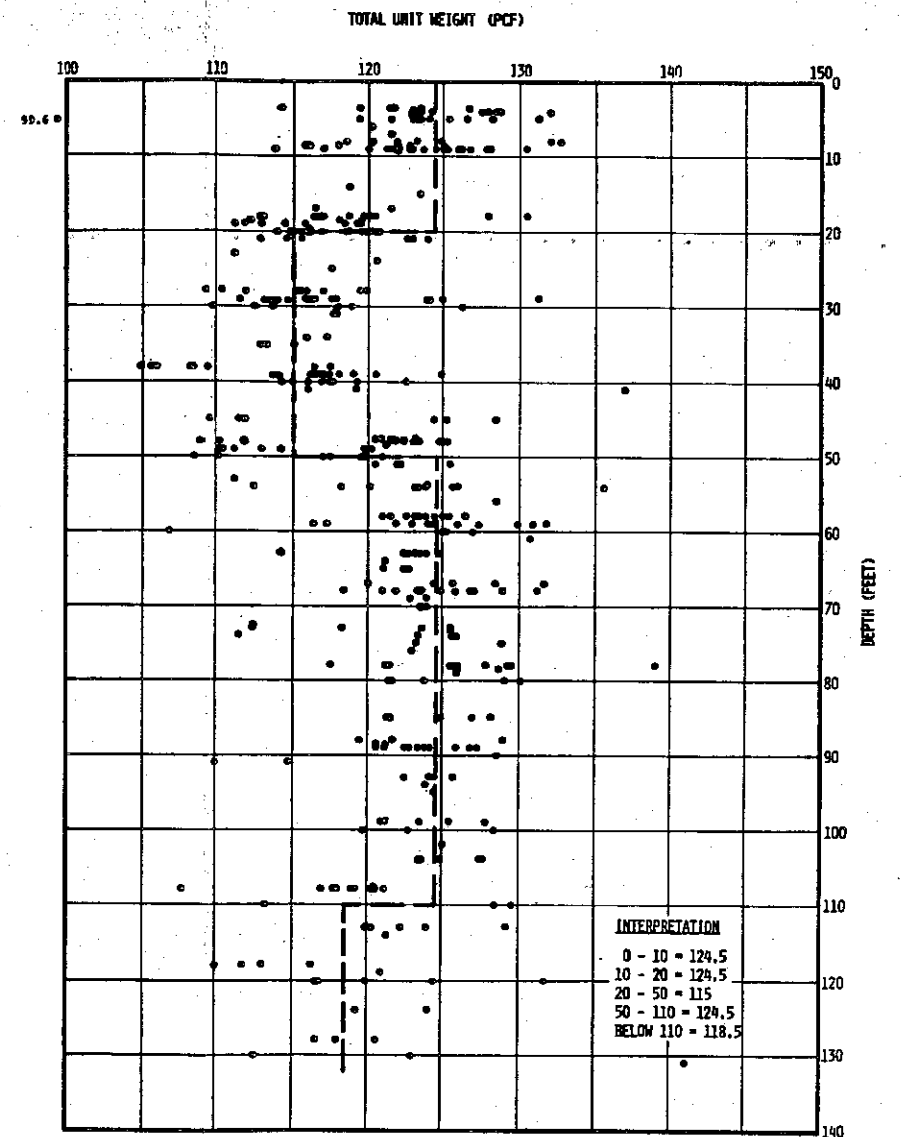
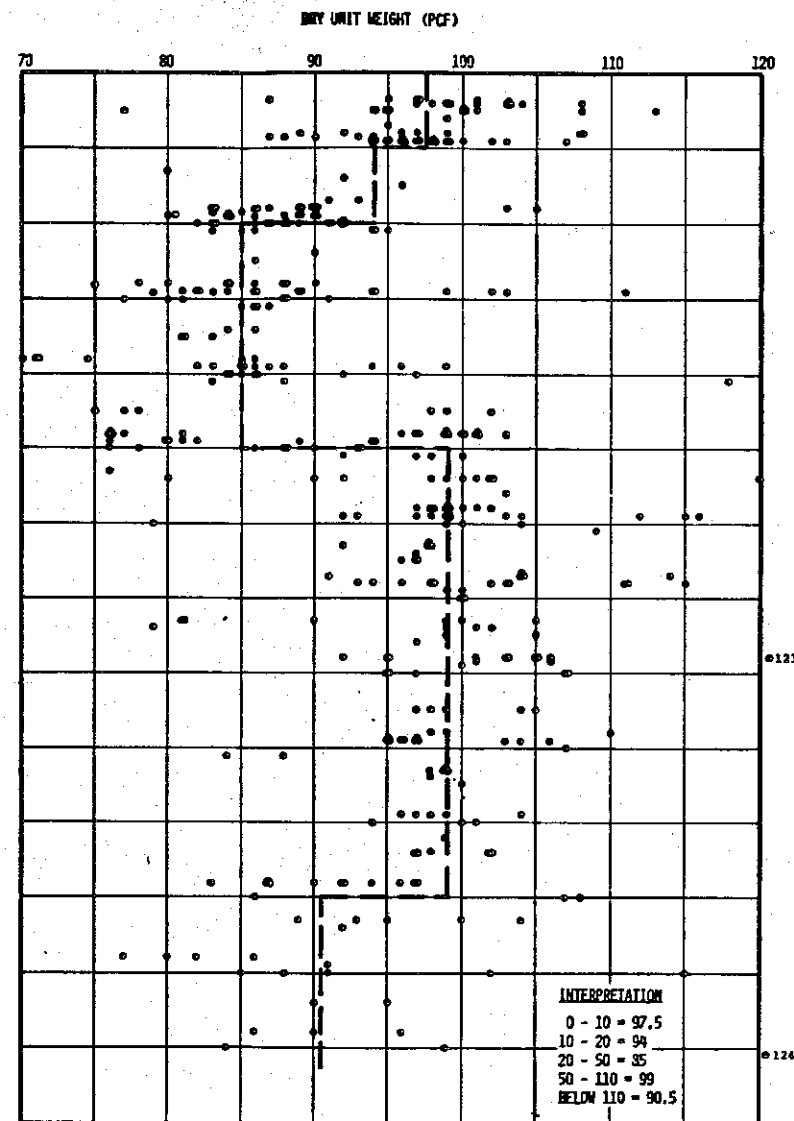
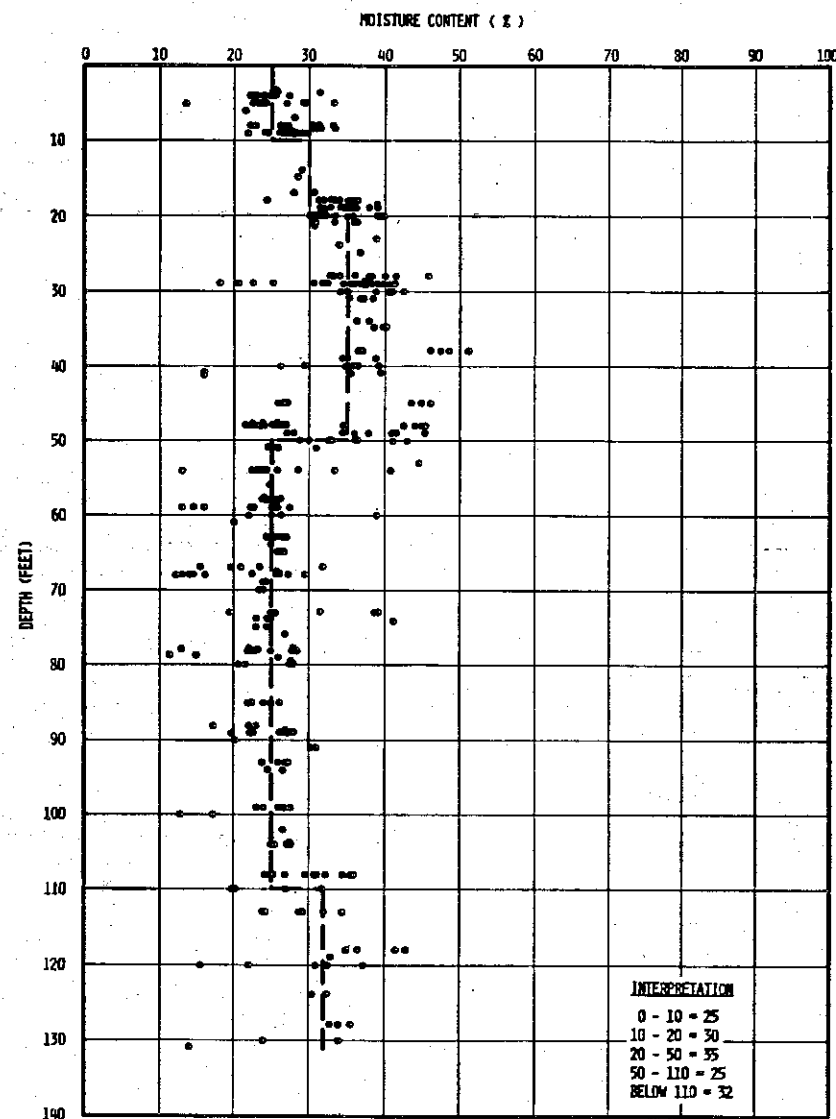


MAIN PLANT AREA


BECHTEL ANN ARBOR		
BELLE RIVER PLANT UNITS 1 & 2		
BLOWCOUNT vs DEPTH SHEET 1 OF 2		
JOB No. 10539	DRAWING No. FIGURE 17	REV. 0



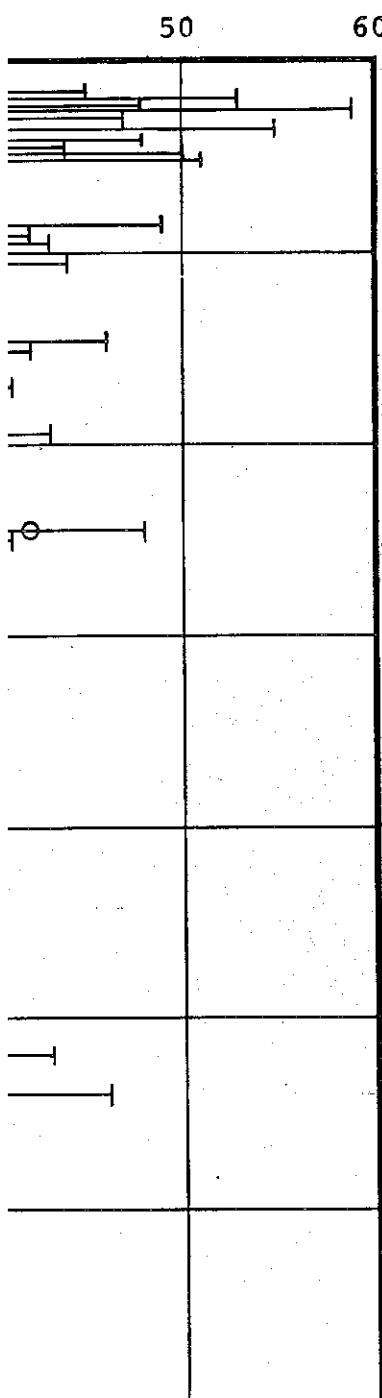
BECHTEL ANN ARBOR		
BELLE RIVER PLANT UNITS 1 & 2		
BLOWCOUNT vs DEPTH SHEET 2 OF 2		
JOB No. 10539	DRAWING No. FIGURE 17	REV. ○



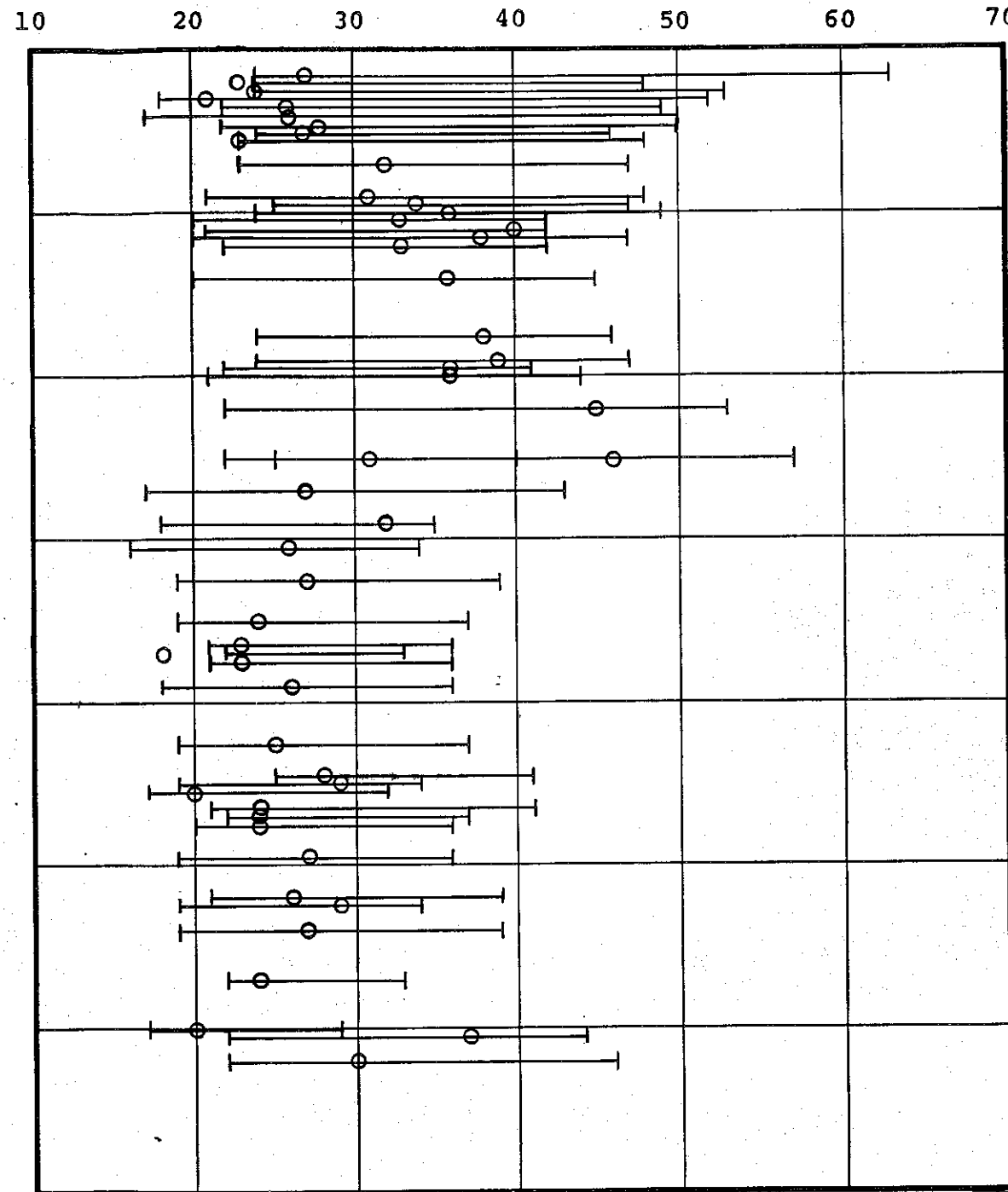
NOTE: DATA INCLUDES RESULTS OF ALL
 TESTS PERFORMED THROUGHOUT THE
 ENTIRE SITE.

BECHTEL ANN ARBOR			
BELLE RIVER PLANT UNIT 1 & 2			
MOISTURE CONTENT, DRY UNIT WEIGHT, AND TOTAL UNIT WEIGHT VS DEPTH			
	JOB NO.	DRAWING NO.	REV.
	10539	FIGURE 18	0

PERCENT)

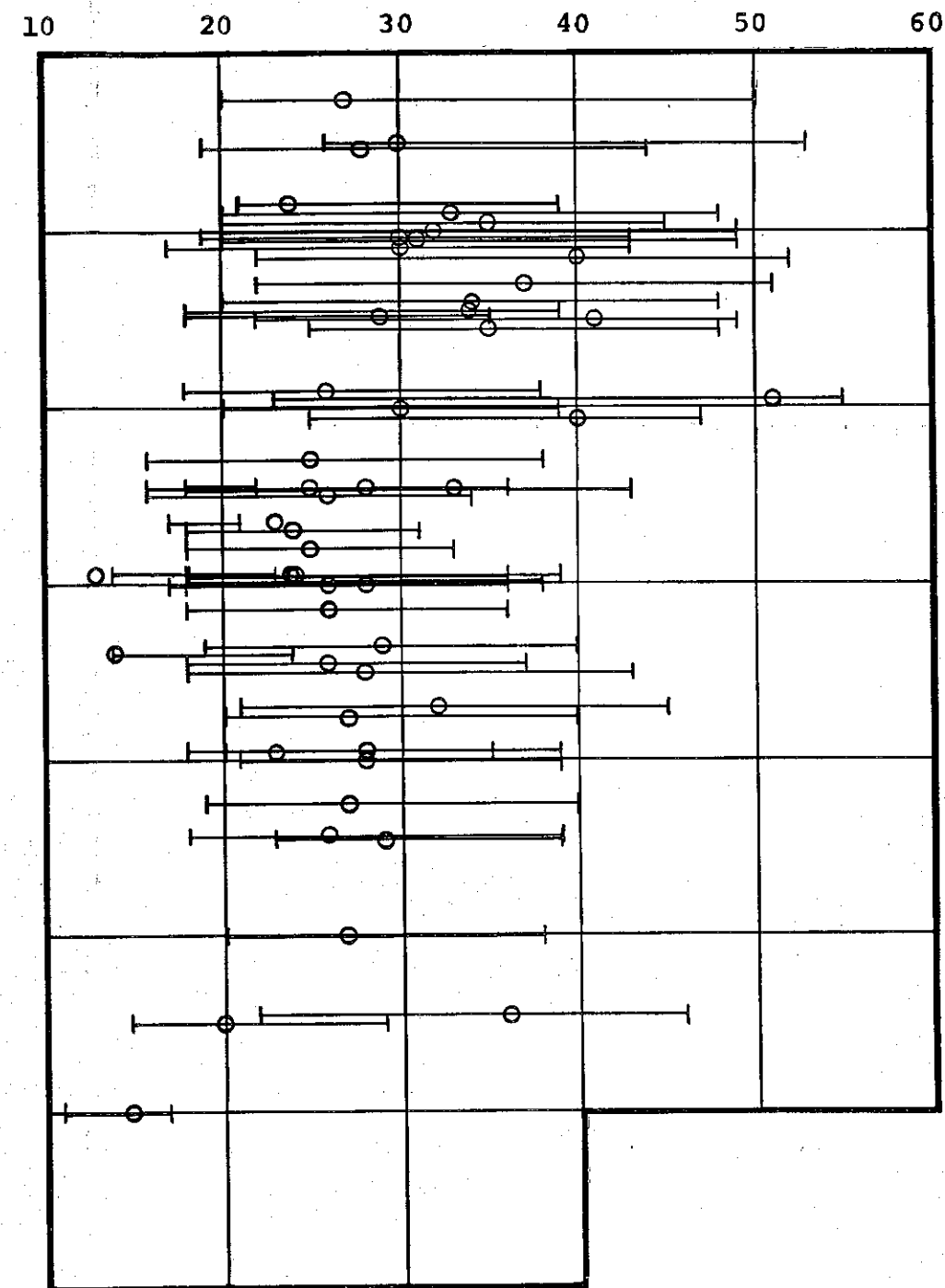


MOISTURE CONTENT (PERCENT)



MAIN COAL STORAGE AREA

MOISTURE CONTENT (PERCENT)



DOCK AREA

LEGEND

W: NATURAL MOISTURE CONTENT
PL: PLASTIC LIMIT
LL: LIQUID LIMIT



BECHTEL
ANN ARBOR

BELLE RIVER PLANT
UNIT 1 & 2

ATTERBERG LIMITS AND NATURAL
MOISTURE CONTENT VS DEPTH



JOB NO.

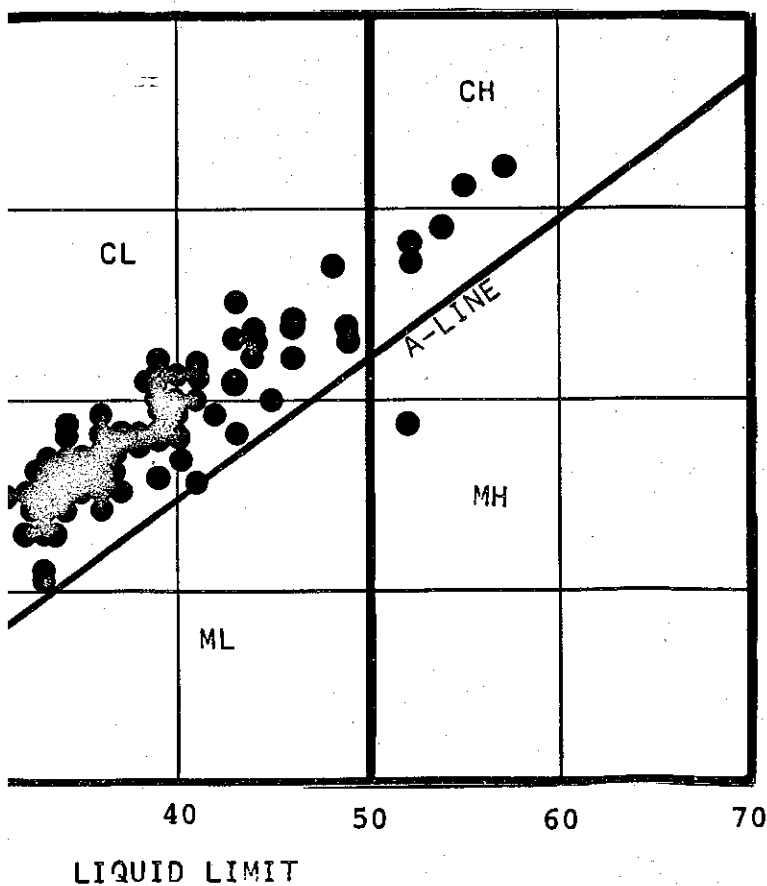
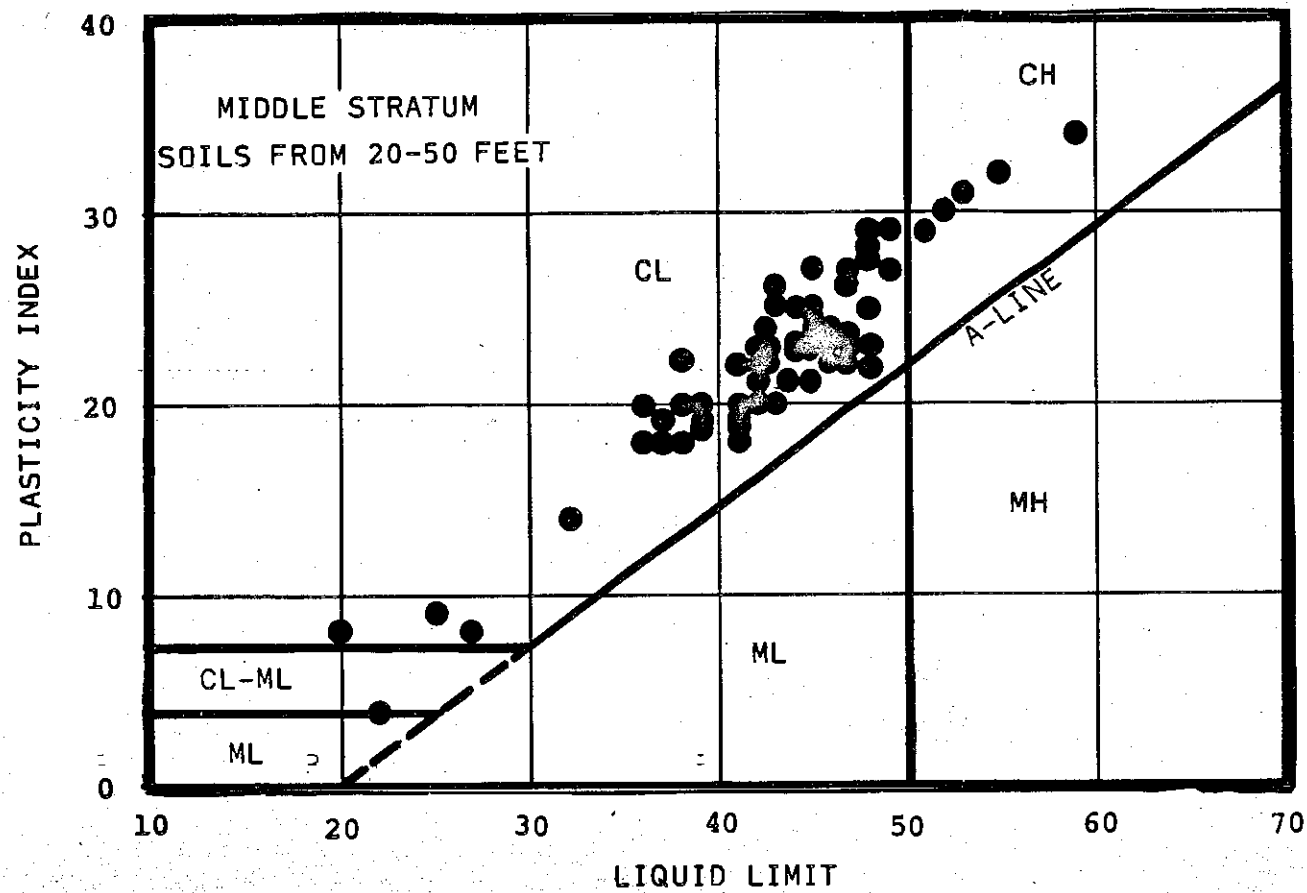
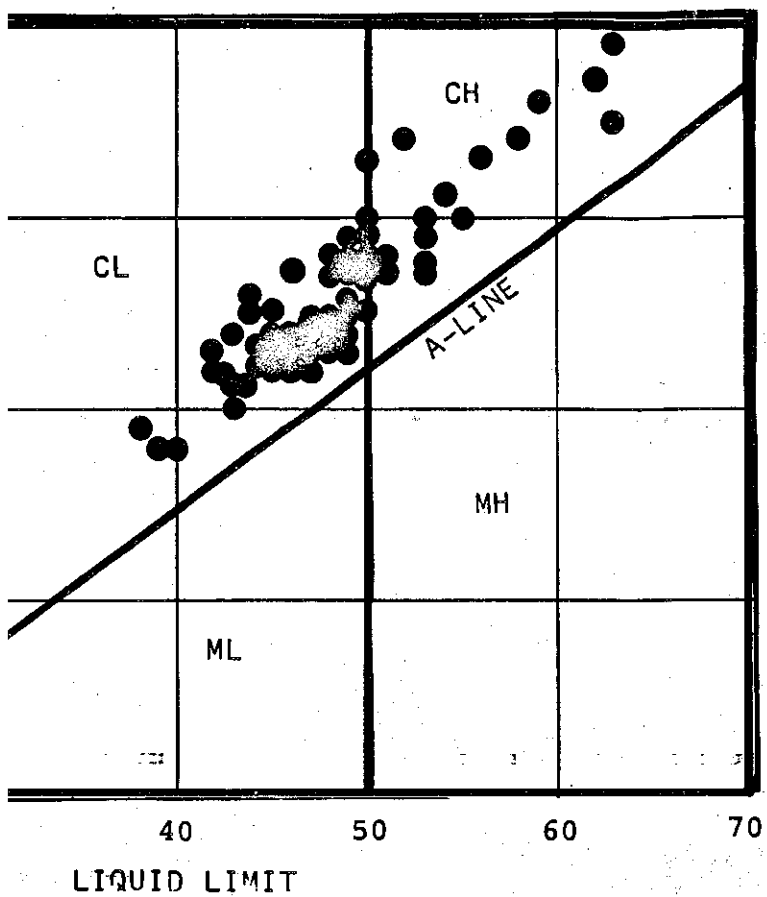
10539

DRAWING NO.

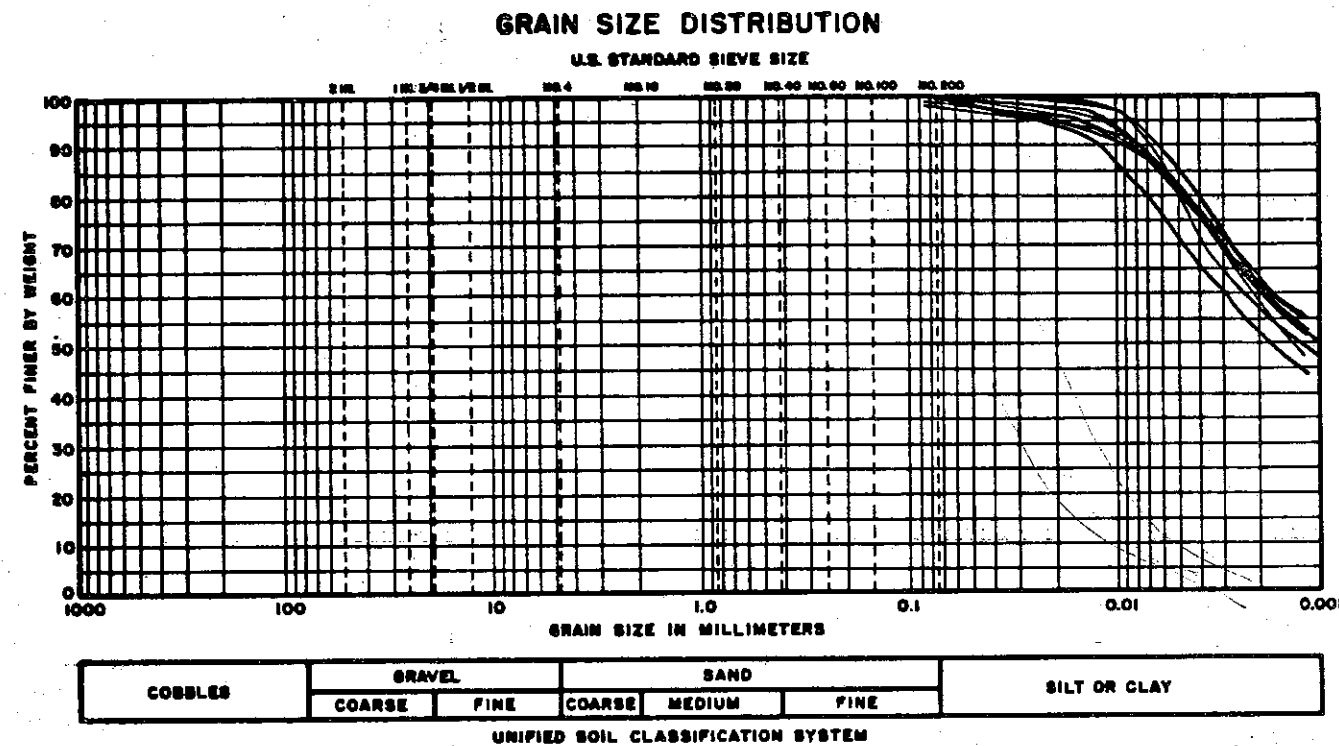
FIGURE 20

REV.

○

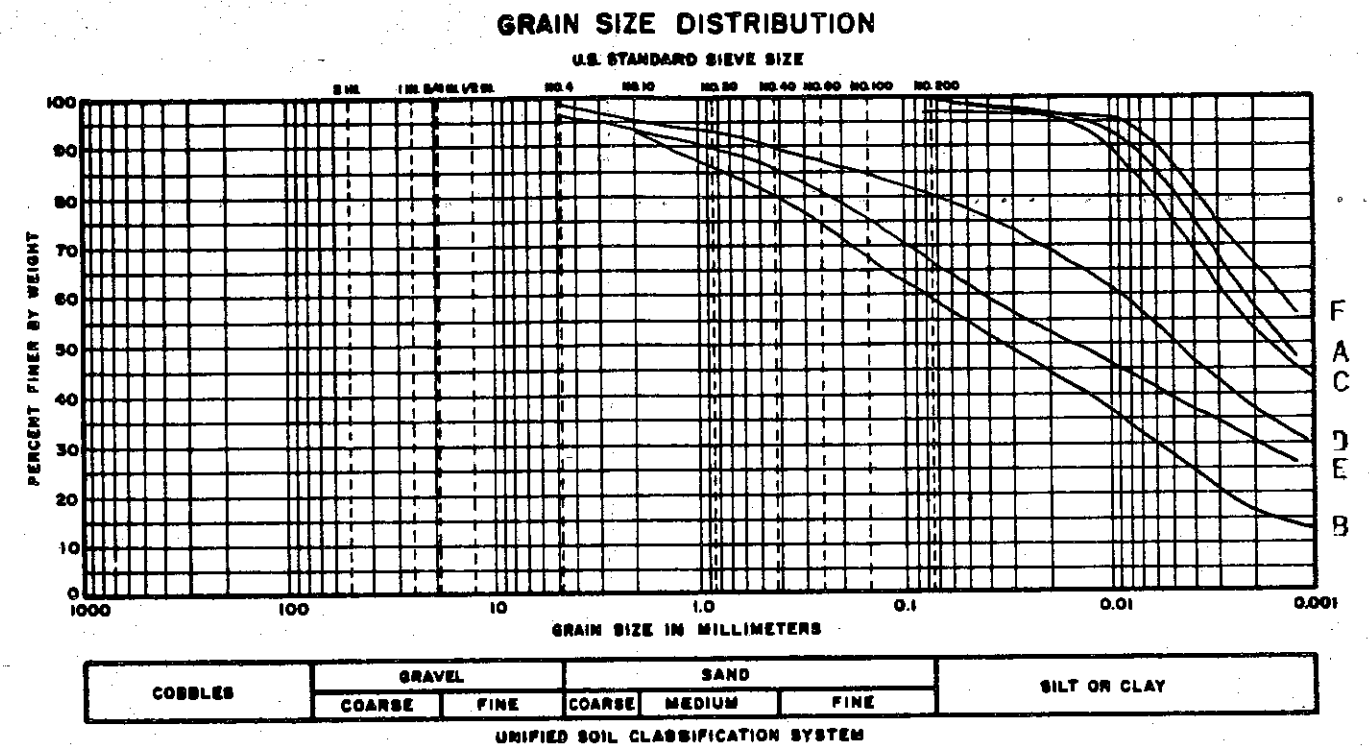


BECHTEL ANN ARBOR			
BELLE RIVER PLANT UNIT 1 & 2			
PLASTICITY CHART			
BECHTEL	JOB NO.	DRAWING NO.	REV.
	10539	FIGURE 19	0



UPPER STRATUM (0-20 FEET)

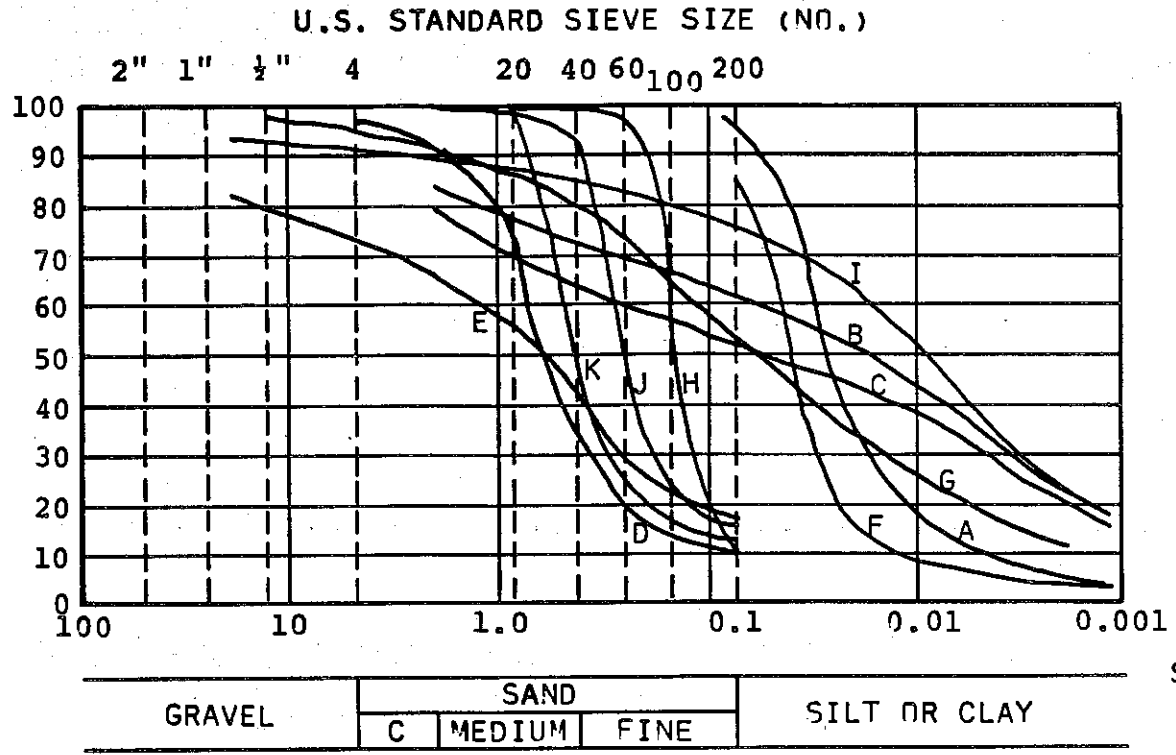
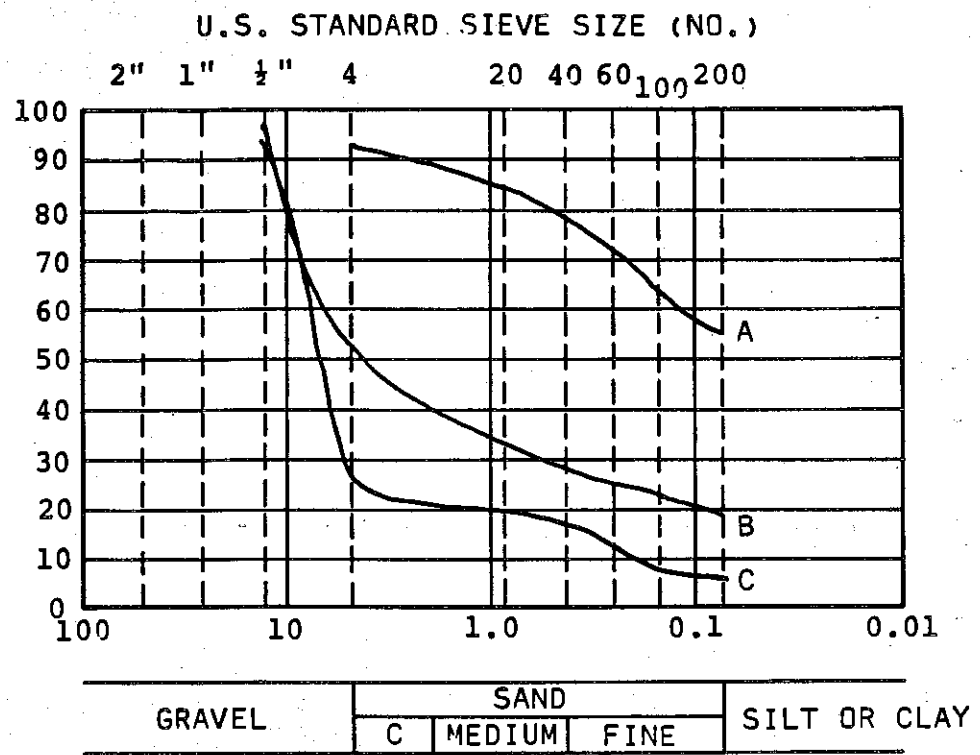
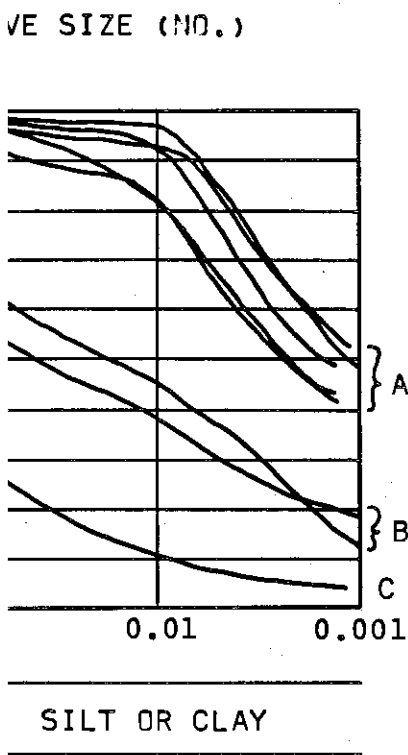
BORING NUMBER	SAMPLE DEPTH (FEET)
38 (CL-CH)	9
38 (CL-CH)	15
41 (CH)	5
48 (CL-CH)	9
60 (CL-CH)	5
60 (CL)	11
60 (CL)	18
60 (CL)	19
137 (CL-CH)	2
144 (CL)	14
151A (CL-CH)	8



MIDDLE STRATUM (20-50 FEET)

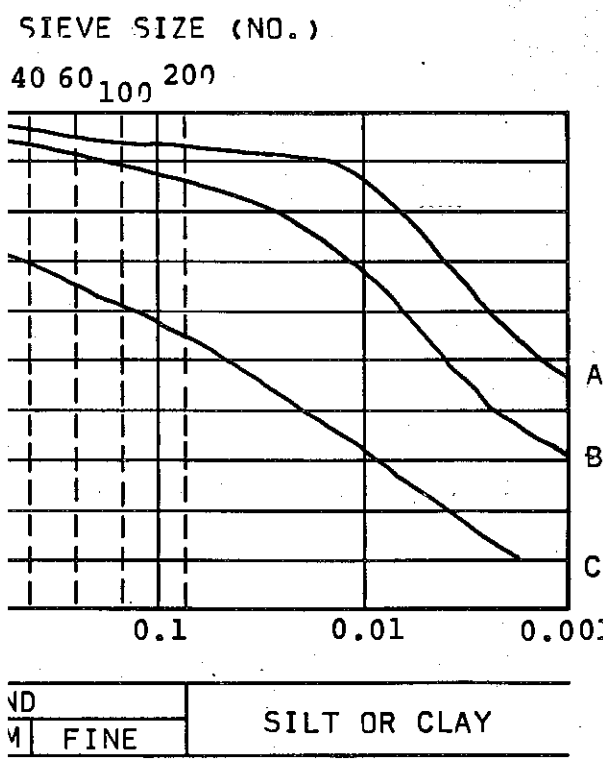
BORING NUMBER	SAMPLE DEPTH (FEET)
A 41 (CL)	20
B 41 (SC)	40
C 50 (CL)	28
D 50 (CL)	48
E 53 (CL)	39
F 60 (CL-CH)	27

BECHTEL ANN ARBOR			
BELLE RIVER PLANT UNIT 1 & 2			
GRAIN SIZE DISTRIBUTION UPPER AND MIDDLE STRATA			
	JOB NO.	DRAWING NO.	REV.
	10539	FIGURE 21	0

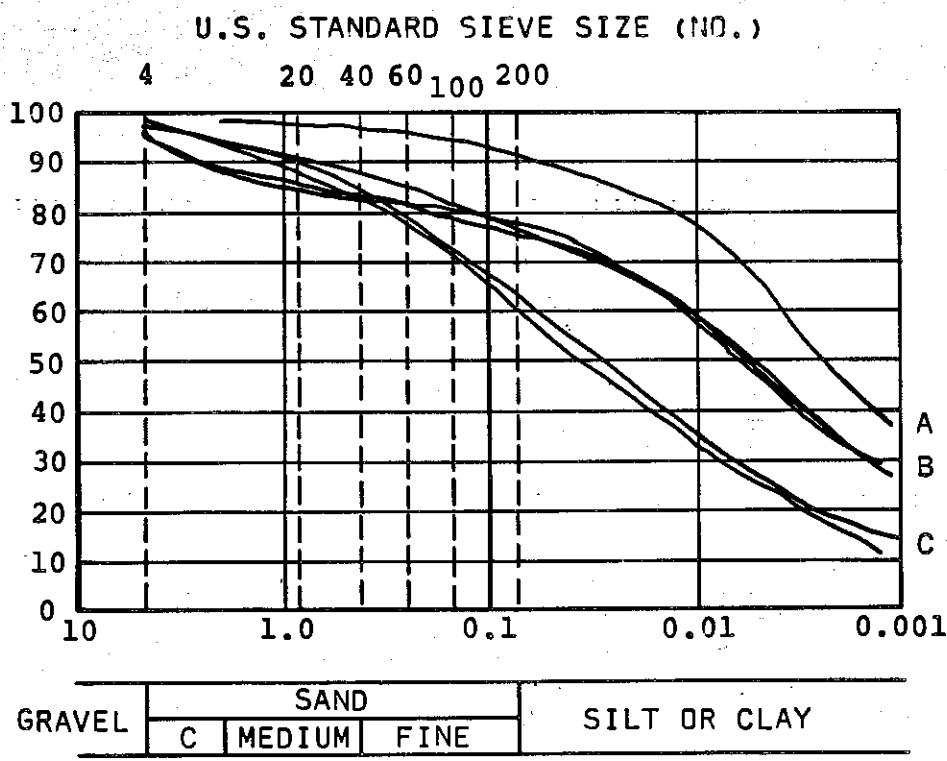


MAIN PLANT AREA		
BORING NUMBER	SAMPLE DEPTH (FEET)	
A	7 (CL-ML)	130
B	7 (CL-ML)	139
C	10 (CL-ML)	141
D	18 (SM-SW)	104
E	18 (SM)	140
F	22 (CL-ML)	134
G	27 (CL-ML)	69
H	27 (SM-SP)	114
I	30 (CL)	69
J	30 (SM)	99
K	30 (SM)	119

AREA EAST OF MAIN PLANT



NORTHWEST FLY ASH DISPOSAL AREA



MAIN PLANT AREA

NORTHWEST FLY ASH DISPOSAL AREA

BORING NUMBER	SAMPLE DEPTH (FEET)	
C	139 (GP)	100
B	141 (GM)	115
A	141 (SM-SC)	145

MAIN COAL STORAGE AREA

BORING NUMBER	SAMPLE DEPTH (FEET)	
A	48 (CL)	118
B	49 (CL)	63
C	187 (CL-ML)	59

DOCK AREA

BORING NUMBER	SAMPLE DEPTH (FEET)	
C	52 (CL)	58.6
B	54 (CL)	63.5
A	54 (CL)	73.7
B	60 (CL)	56.1
B	60 (CL)	85.6
C	60 (CL)	119.5

STORAGE AREA


DOCK AREA

- NOTES:
- 1) ALL SOILS ARE BELOW 50 FEET.
 - 2) SOIL DIVISIONS AS PER UNIFIED SOIL CLASSIFICATION SYSTEM

BECHTEL
ANN ARBOR

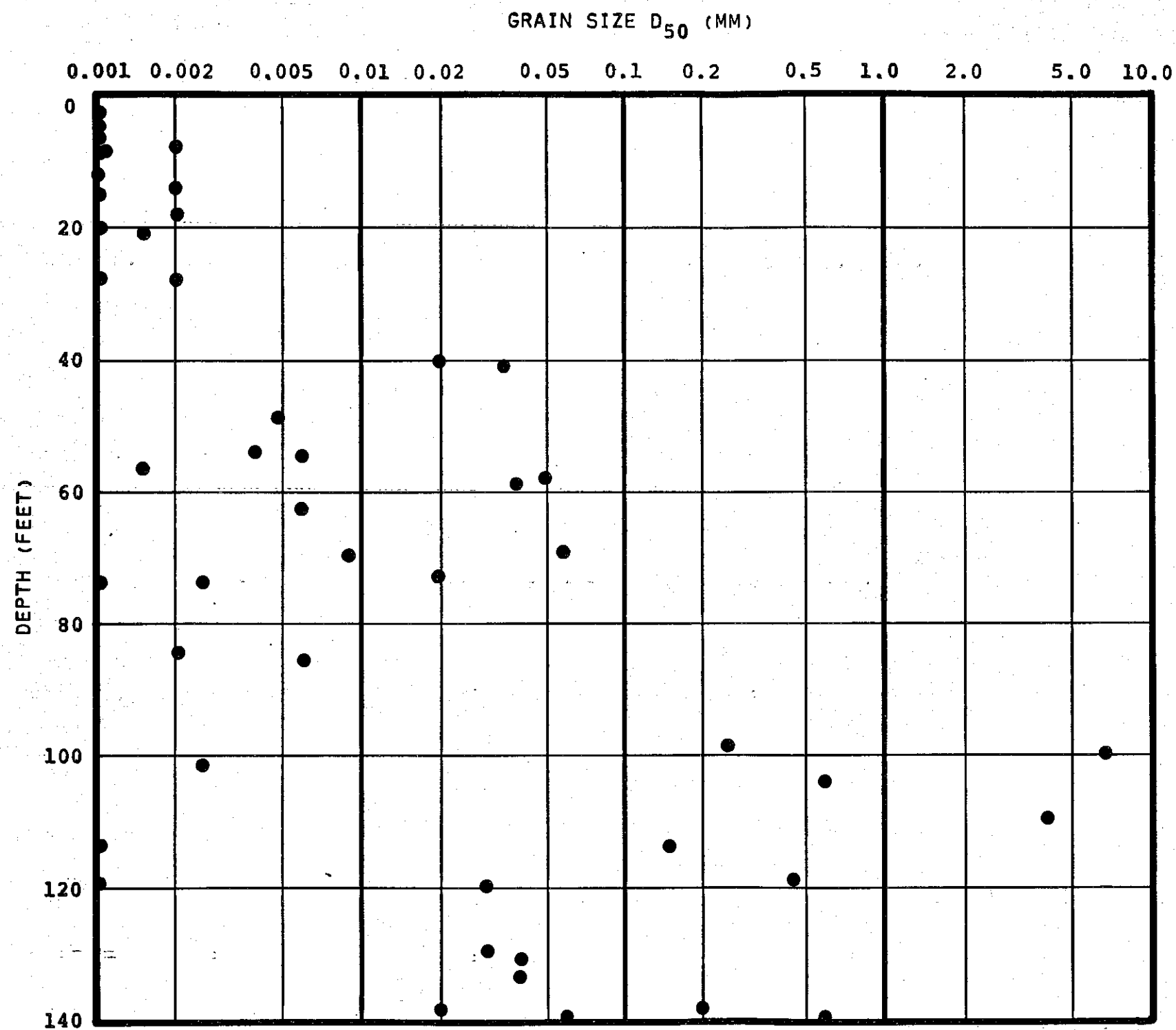
BELLE RIVER PLANT
UNIT 1 & 2

GRAIN SIZE DISTRIBUTION
LOWER STRATUM

JOB NO.
10539


DRAWING NO.
FIGURE 22

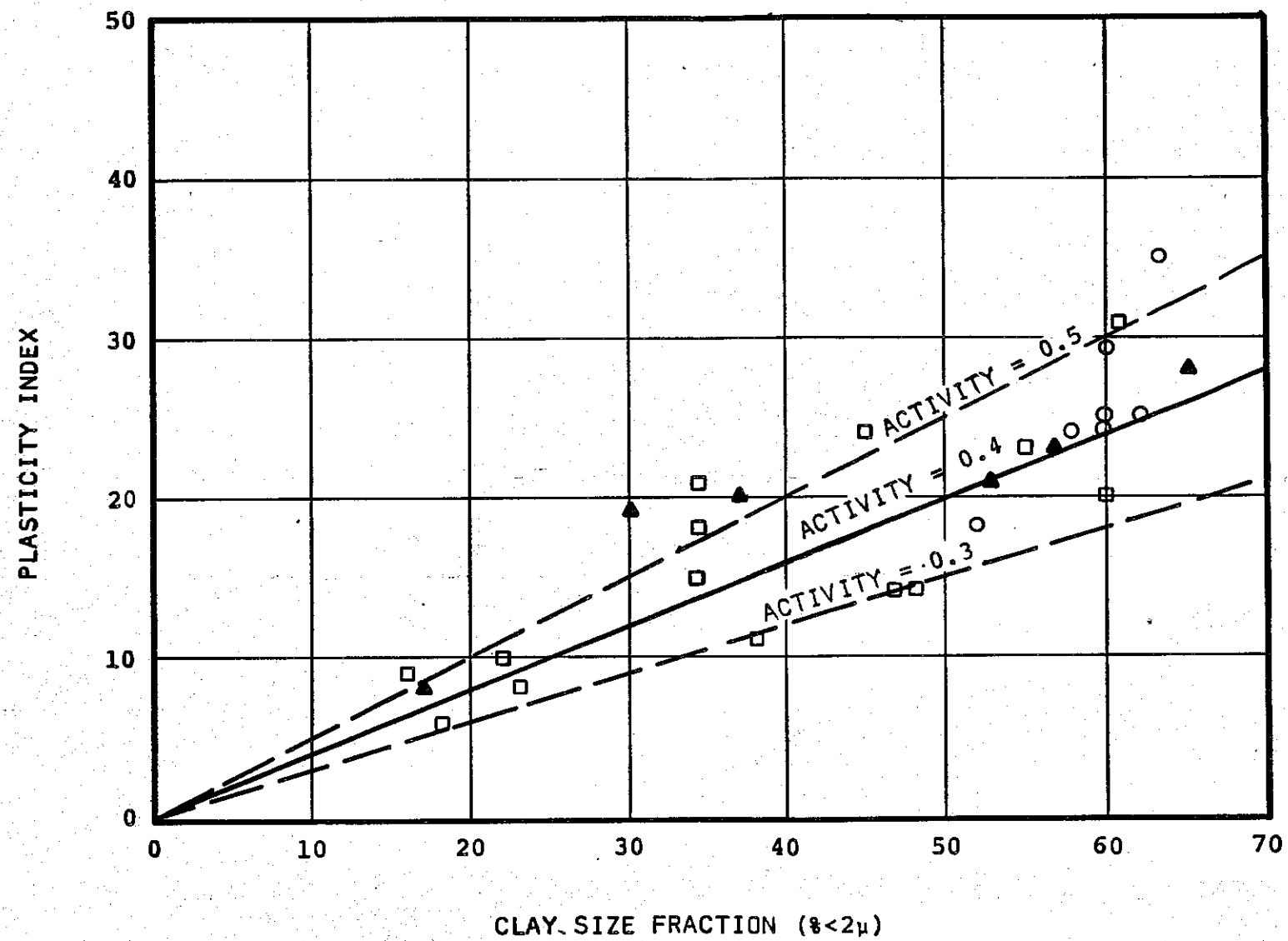
REV.
0



CLAY (PLASTIC) TO SILT (NON-PLASTIC)	SAND			GRAVEL
	FINE	MEDIUM	COARSE	

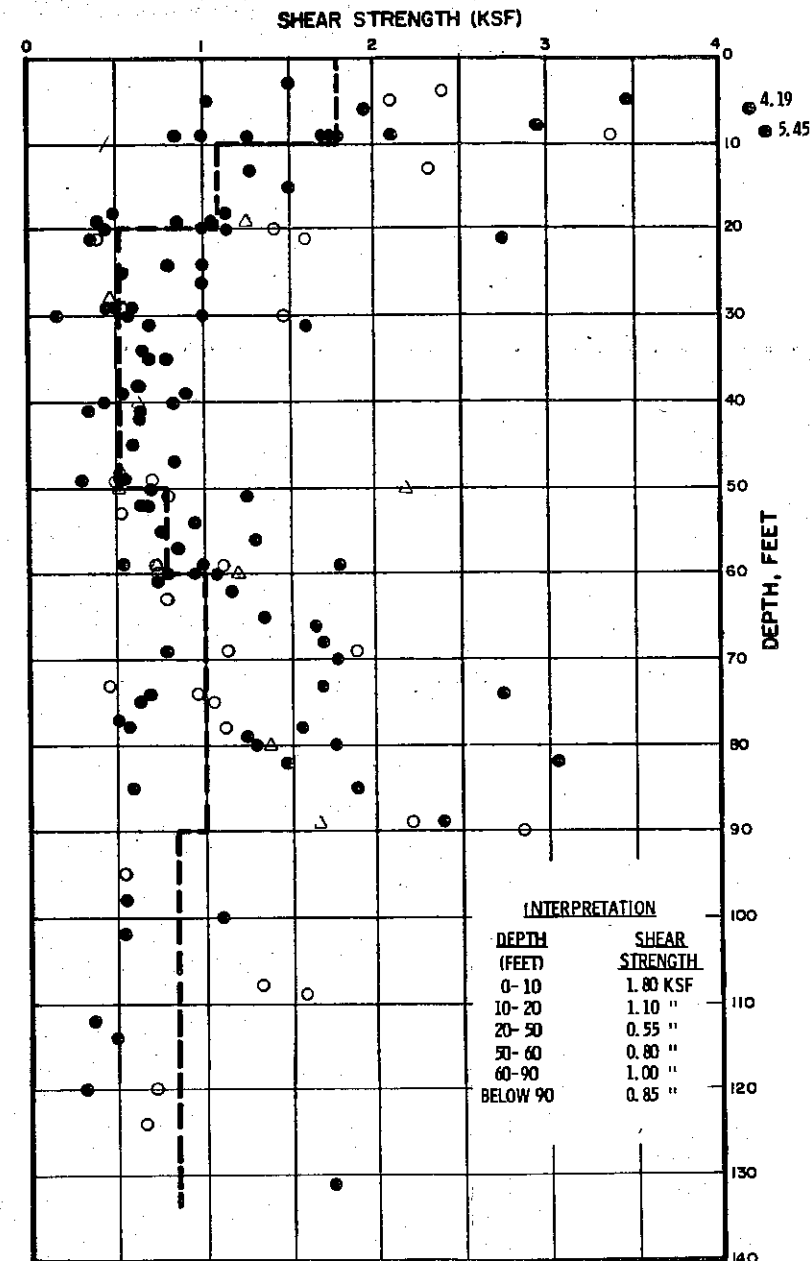
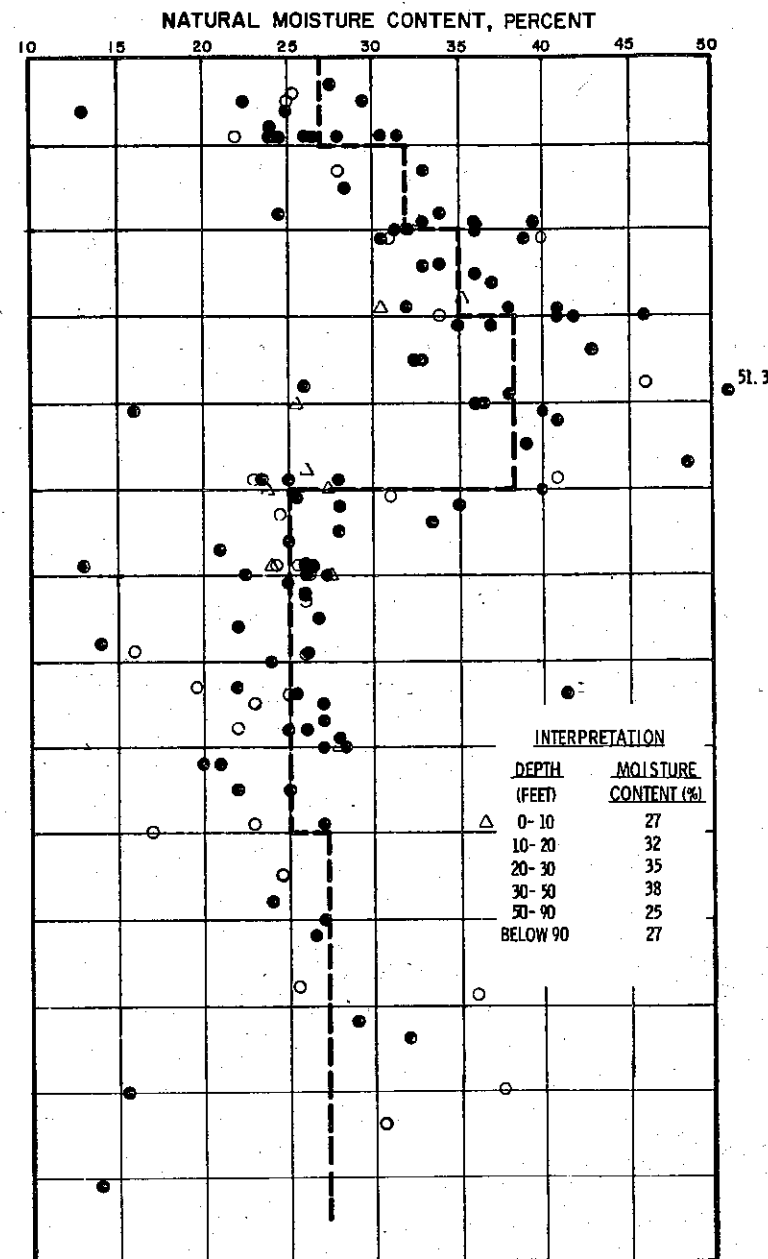
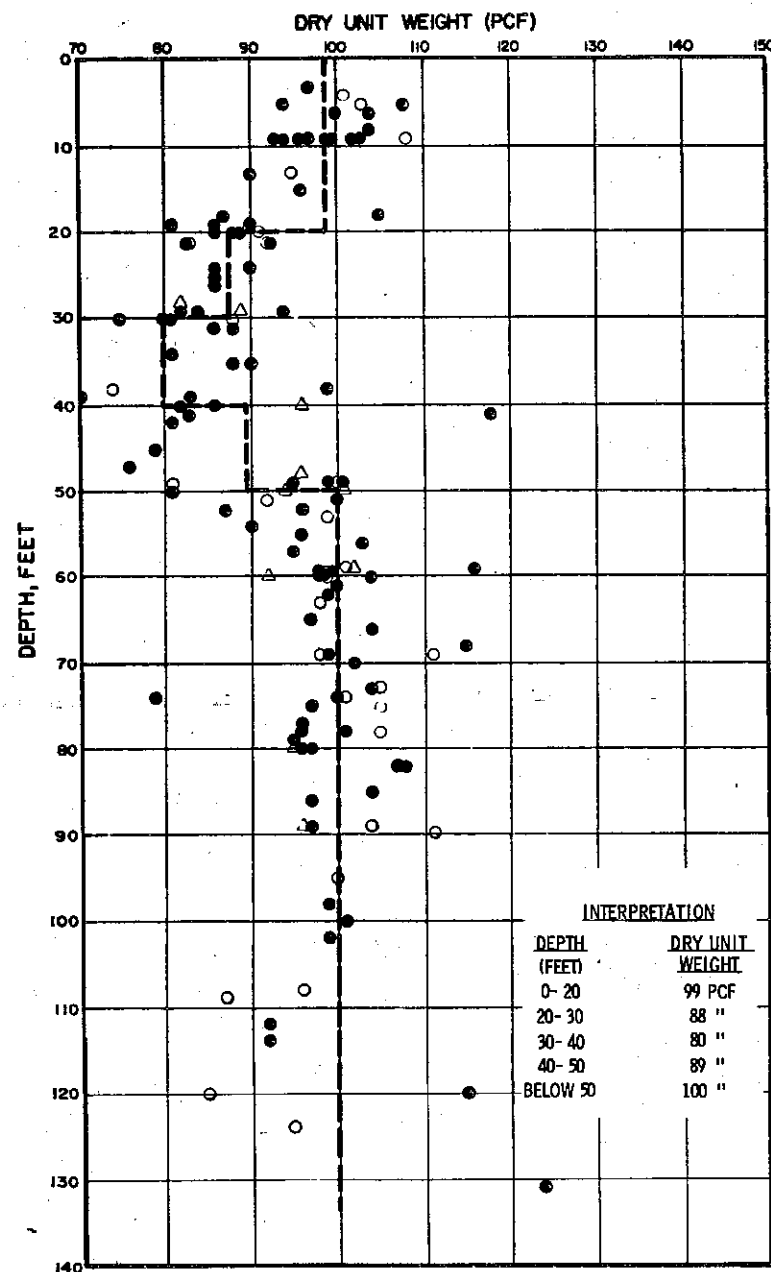
UNIFIED SOIL CLASSIFICATION SYSTEM

BECHTEL ANN ARBOR			
BELLE RIVER PLANT UNIT 1 & 2			
GRAIN SIZE (D_{50}) VS DEPTH			
	JOB NO. 10539	DRAWING NO. FIGURE 23	REV. ○



- SOILS FROM 0-20 FEET
 - ▲ SOILS FROM 20-50 FEET
 - SOILS BELOW 50 FEET
- ACTIVITY = $PI / \% < 2\mu$

BECHTEL ANN ARBOR			
BELLE RIVER PLANT UNITS 1 & 2			
ACTIVITY OF CLAY SOILS			
BECHTEL	JOB No.	DRAWING No.	REV.
	10539	FIGURE 24	C



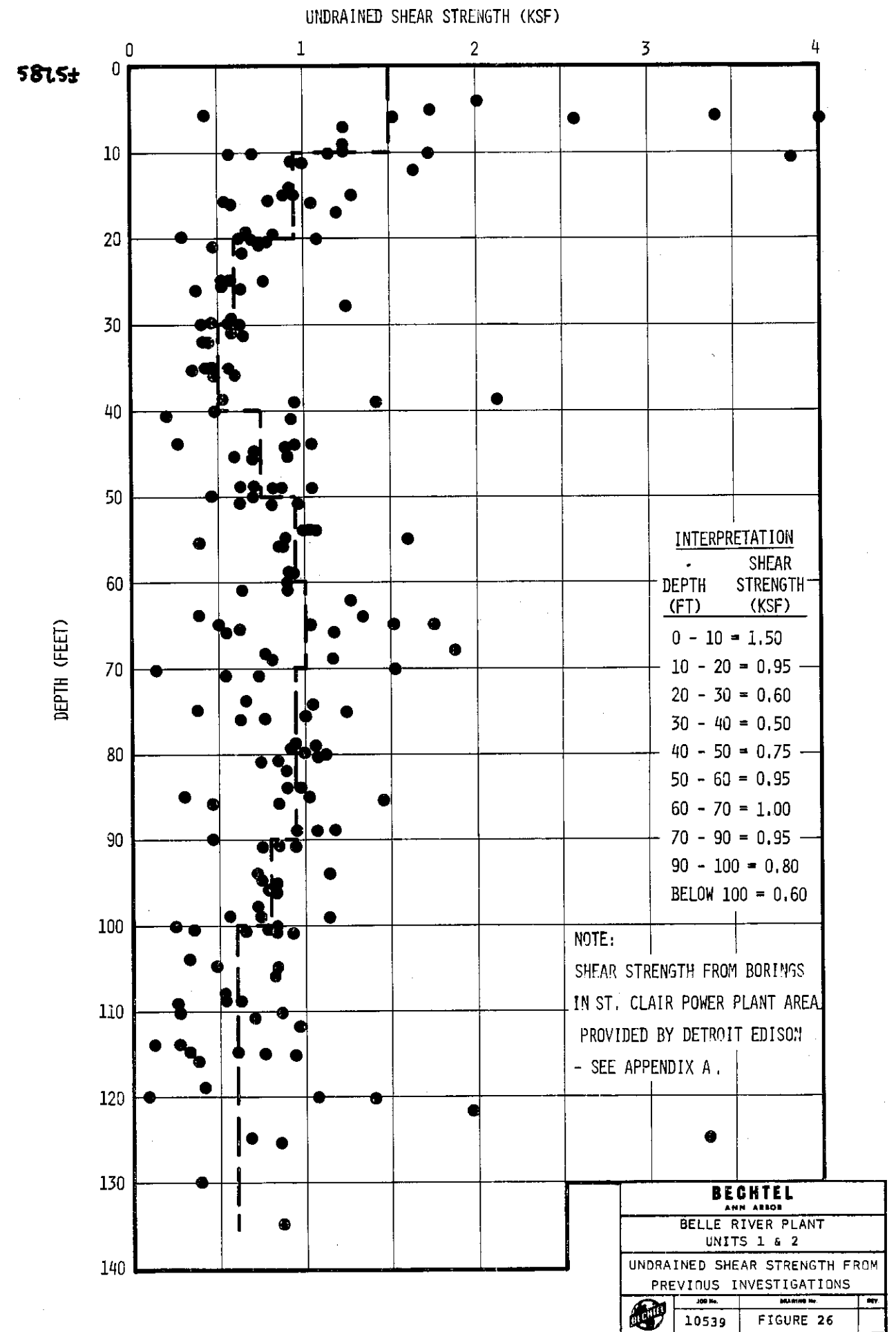
EXPLANATION

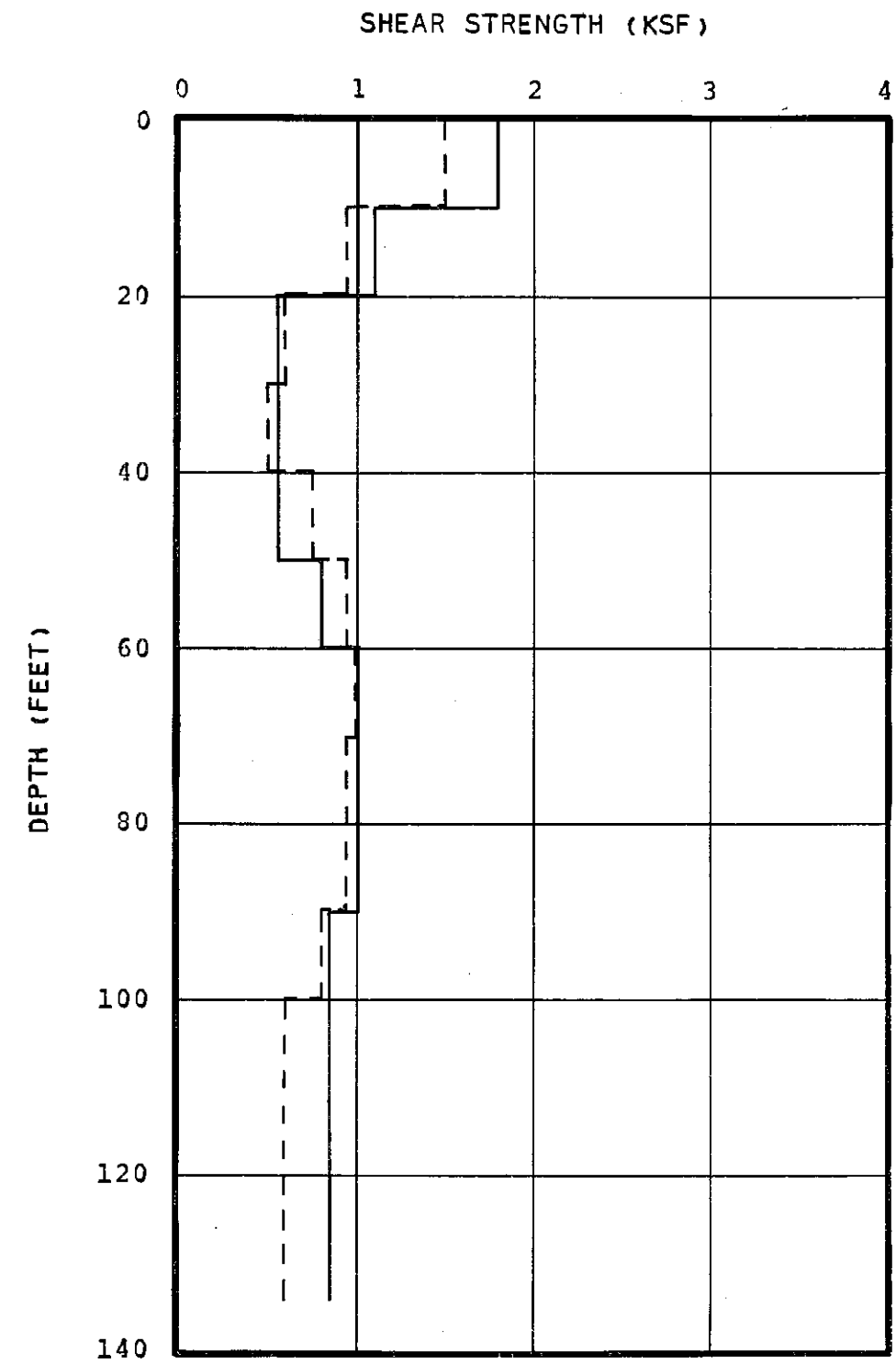
- UNCONFINED COMPRESSION TESTS
- UNCONSOLIDATED UNDRAINED TESTS
- △ LABORATORY VANE SHEAR TESTS

NOTES:

- 1.) ALL VALUES REPRESENT PEAK STRENGTHS.
- 2.) DRY UNIT WEIGHT AND NATURAL MOISTURE CONTENT CORRESPOND TO SHEAR STRENGTH TEST RESULTS.

BECHTEL			
ANN ARBOR			
BELLE RIVER PLANT			
UNIT 1 & 2			
DRY UNIT WEIGHT, NATURAL WATER CONTENT, AND SHEAR STRENGTH VS DEPTH, ENTIRE SITE			
	JOB NO.	DRAWING NO.	REV.
	10539	FIGURE 25	0



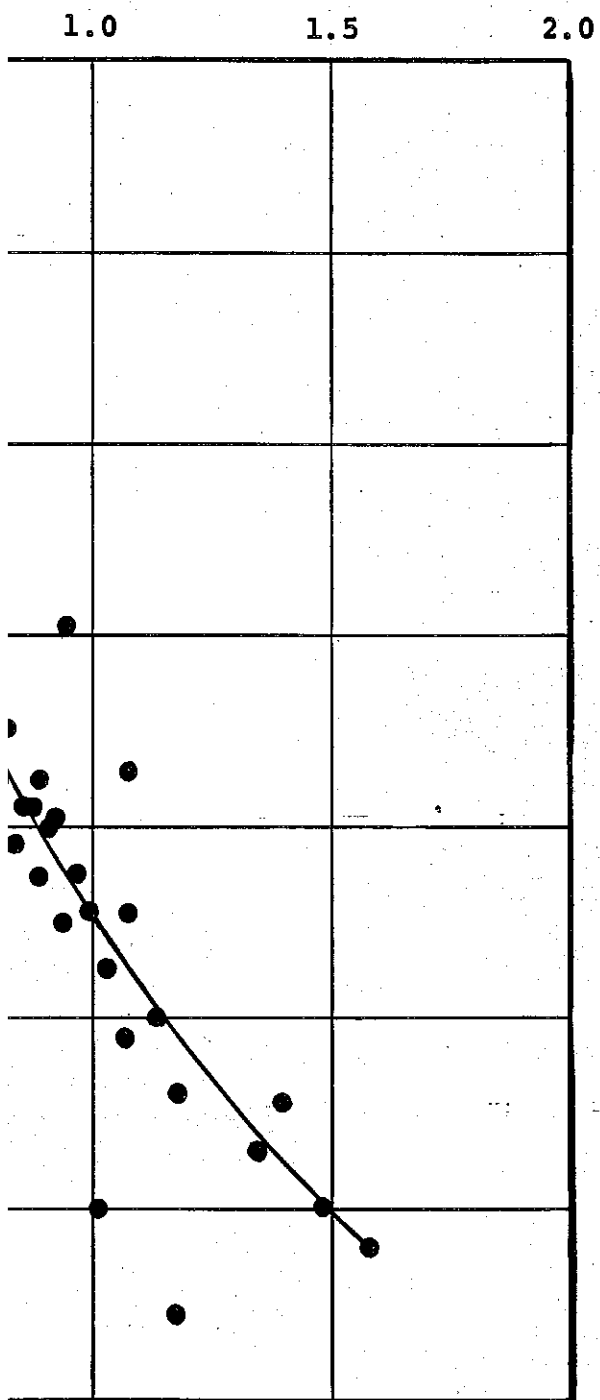


— — — HOUSE UNDRAINED SHEAR
STRENGTH DATA (SEE FIG. 26)

———— BECHTEL UNDRAINED SHEAR
STRENGTH DATA (SEE FIG. 25)

BECHTEL			
ANN ARBOR			
BELLE RIVER PLANT			
UNITS 1 & 2			
COMPARISON OF HOUSEL AND BECHTEL UNDRAINED SHEAR STRENGTH			
	JOB NO.	DRAWING NO.	REV.
	10539	FIGURE 27	0

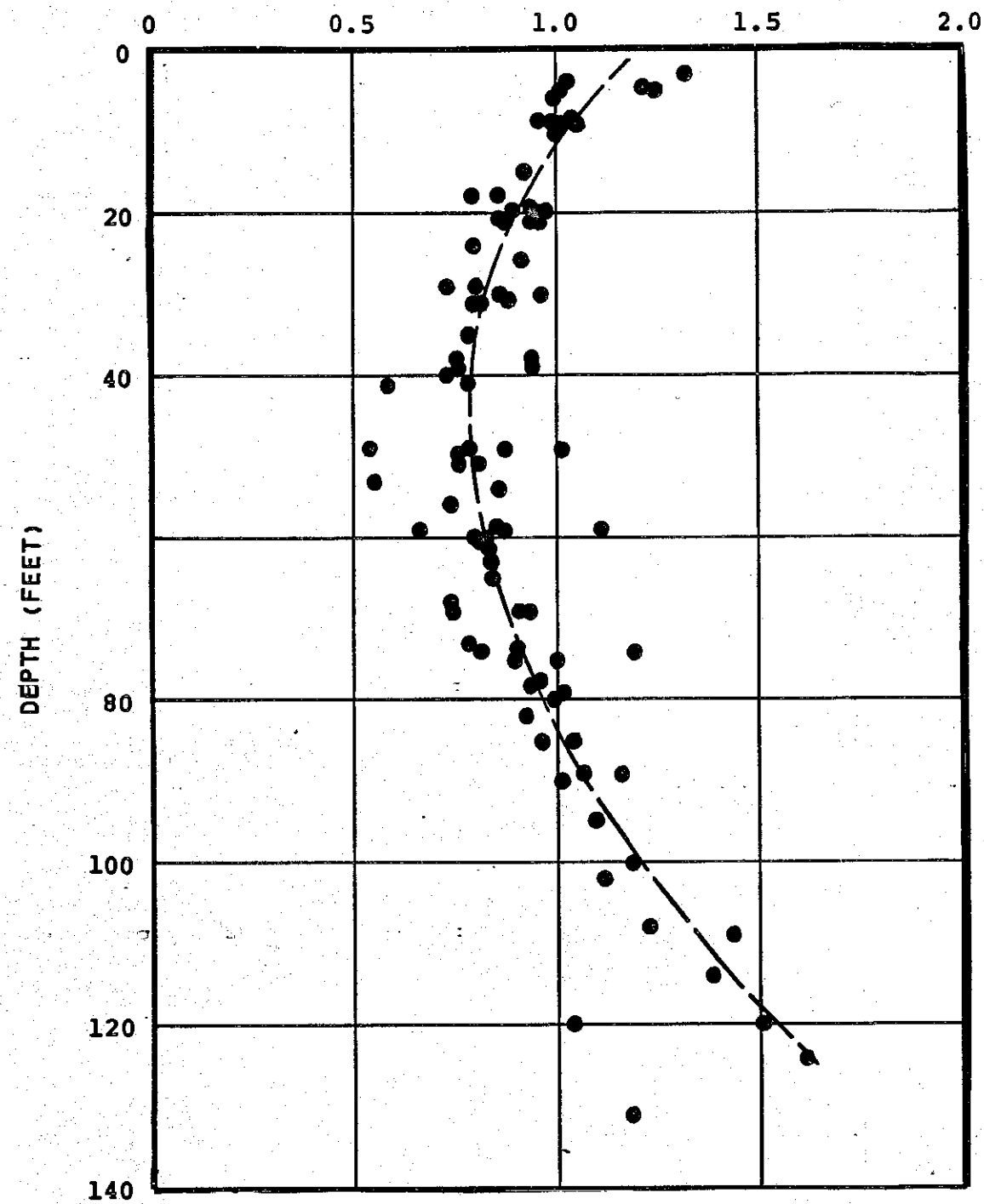
HESSION (KSF)



PRESSURE (P_0) WAS SUBSTITUTED
IN RELATIONSHIP
: P_1 TO OBTAIN COHESION VALUES.

OLIDATED SOILS ASSUMED

COHESION (KSF)



NOTE:

PRECONSOLIDATION PRESSURE P_c (CASAGRANDE'S METHOD)
WAS SUBSTITUTED FOR \bar{P} IN THE SKEMPTON RELATIONSHIP
 $C/\bar{P} = 0.11 + 0.0037 \times P_1$ TO OBTAIN COHESION VALUES.

B) PRECONSOLIDATED SOILS ASSUMED

SOIL DATA

DEPTH (FT)	TOTAL UNIT WEIGHT (PCF)	EFFECTIVE UNIT WEIGHT (PCF)
0-20	125	63
20-50	115	53
50+	125	63

NOTE:

WATER TABLE ASSUMED TO BE AT A DEPTH OF 10 FEET.

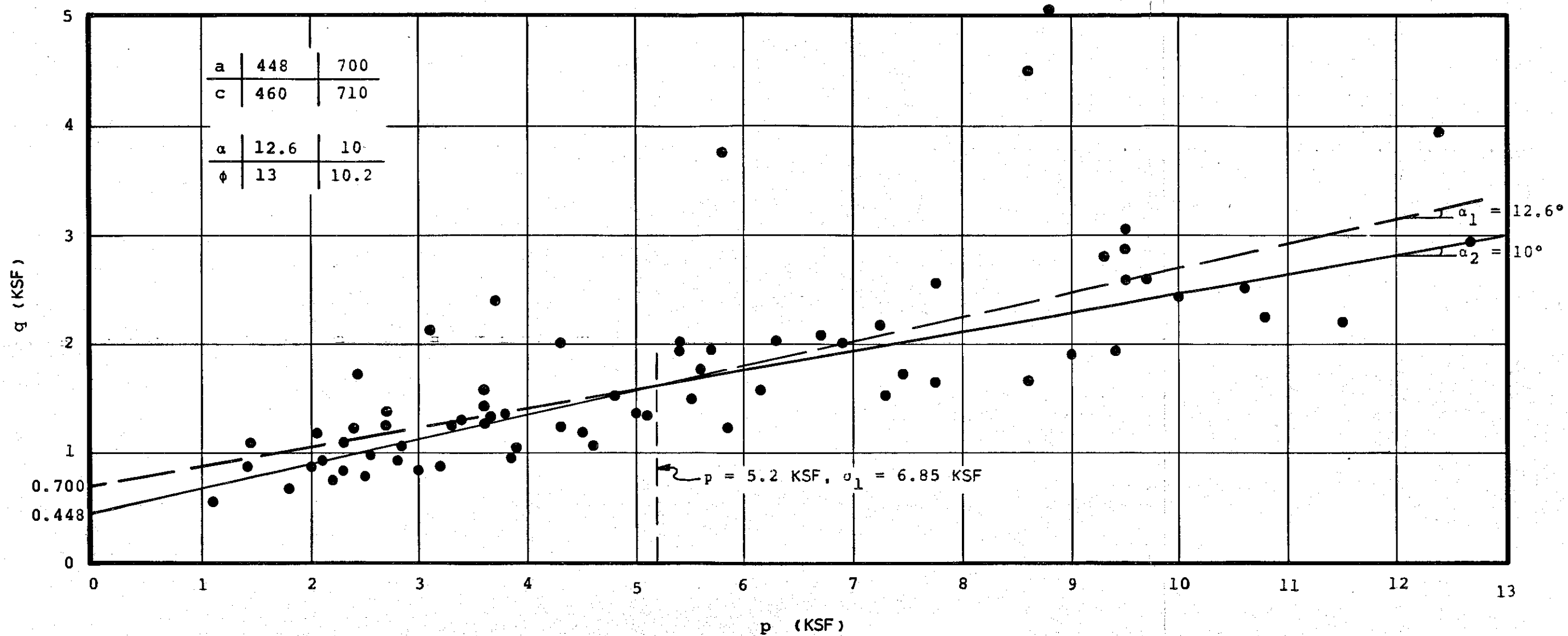
BECHTEL
ANN ARBOR

BELLE RIVER PLANT
UNIT 1 & 2

UNDRAINED SHEAR STRENGTH FROM
SKEMPTON'S RELATIONSHIP



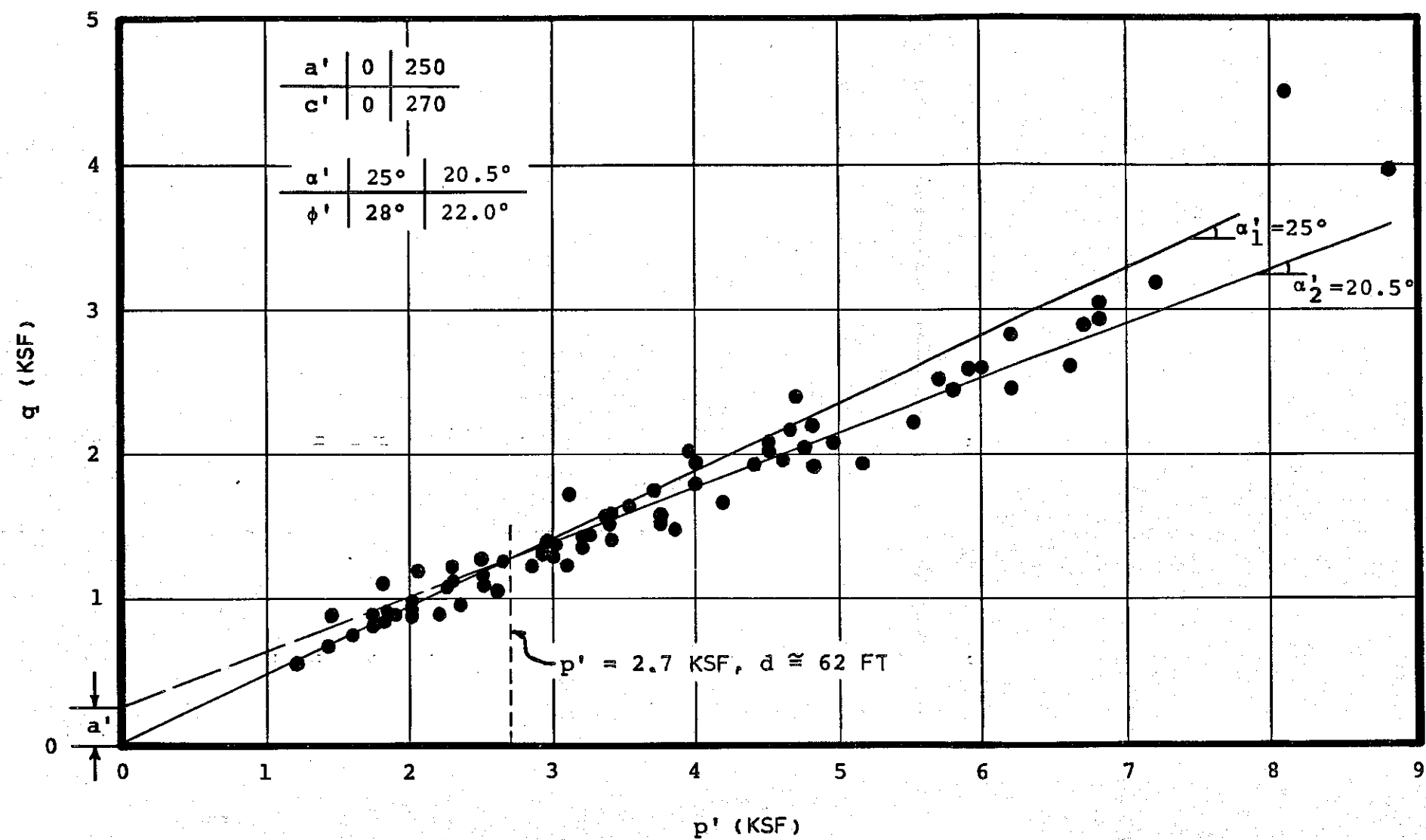
JOB NO.	DRAWING NO.	REV.
10539	FIGURE 28	0



$$p = \frac{\sigma_1 + \sigma_3}{2}$$

$$q = \frac{\sigma_1 - \sigma_3}{2}$$

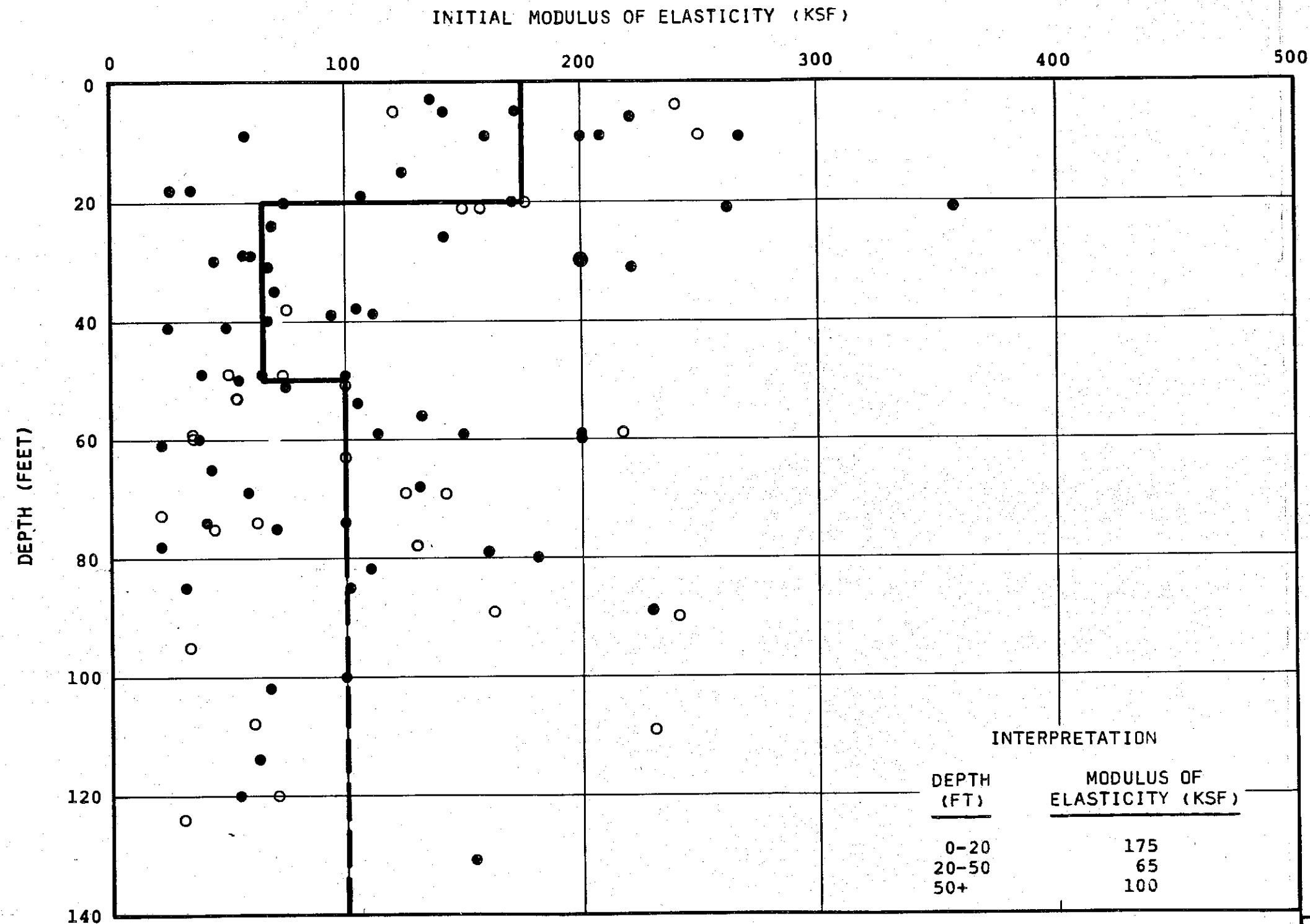
BECHTEL ANN ARBOR		
BELLE RIVER PLANT UNITS 1 & 2		
p - q DIAGRAM ALL CLAYEY SOILS		
JOB No.	DRAWING No.	REV.
10539	FIGURE 29	A



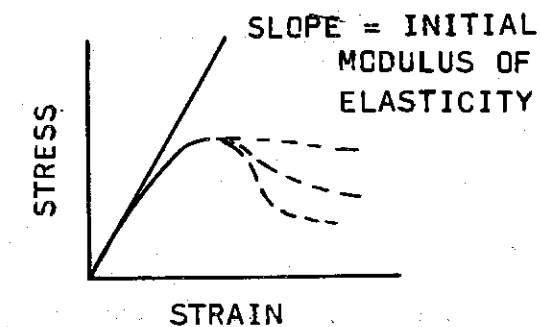
$$p' = \frac{\sigma'_1 + \sigma'_3}{2}$$

$$q = \frac{\sigma'_1 - \sigma'_3}{2}$$

BECHTEL			
ANN ARBOR			
BELLE RIVER PLANT			
UNIT 1 & 2			
p' - q DIAGRAM			
ALL CLAYEY SOILS			
BECHTEL	JOB NO.	DRAWING NO.	REV.
	10539	FIGURE 30	0



DEFINITION



● FROM Q_u TEST

○ FROM U_u TEST

BECHTEL
ANN ARBOR

BELLE RIVER PLANT
UNIT 1 & 2

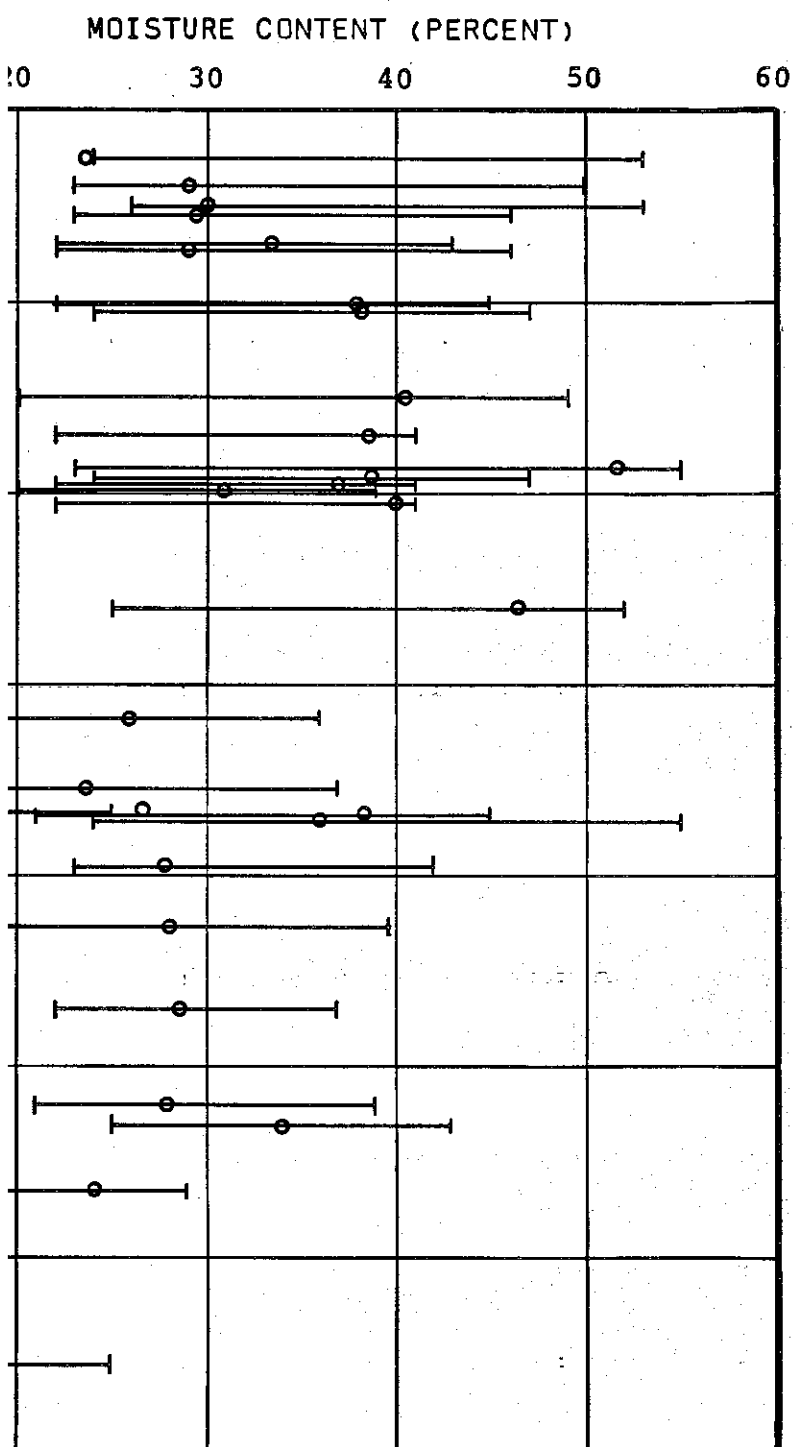
INITIAL MODULUS OF ELASTICITY
VS DEPTH



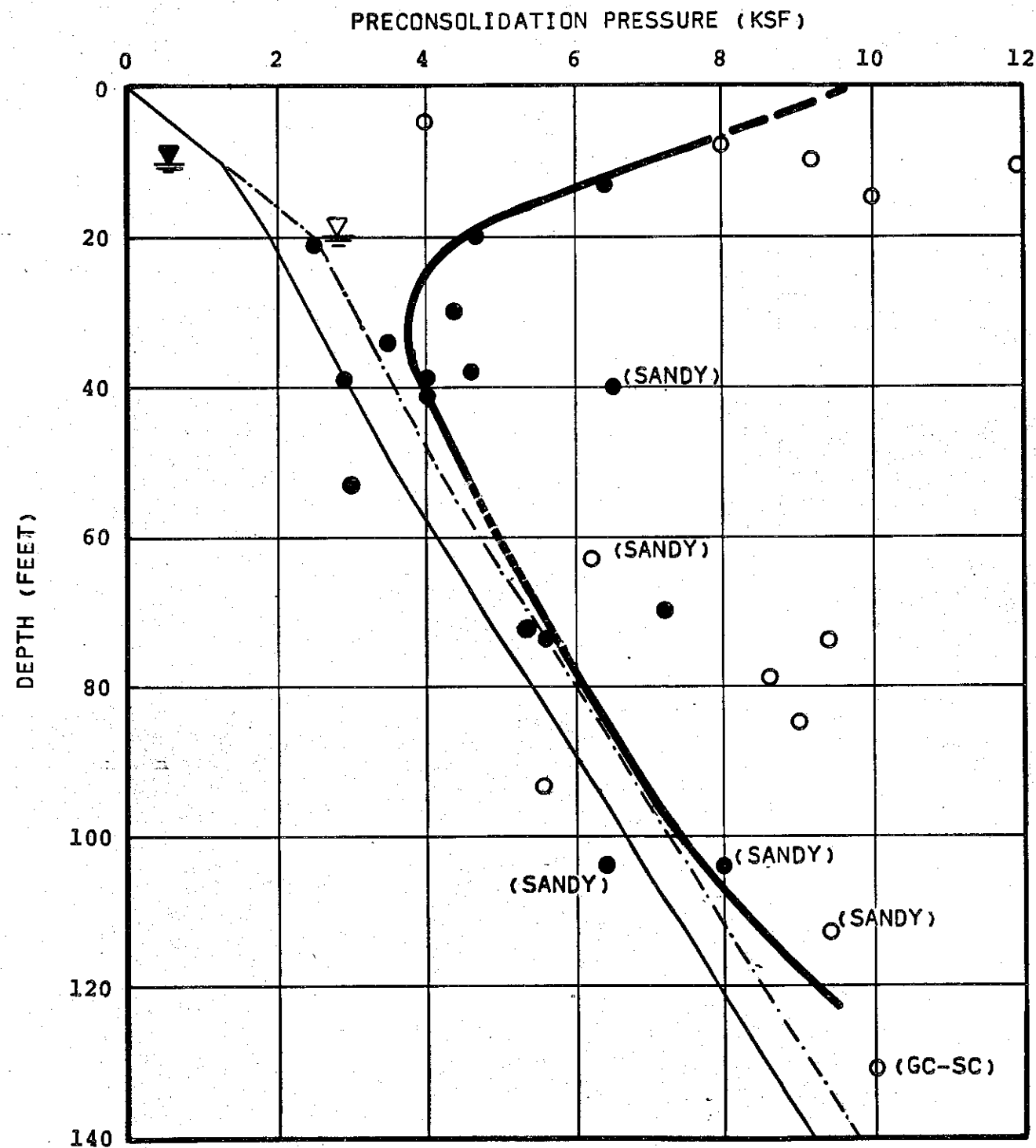
JOB NO.
10539

DRAWING NO.
FIGURE 31

REV.
○



○ NATURAL MOISTURE CONTENT
 — ATTERBERG LIMITS
 LL



● PRECONSOLIDATION PRESSURE FROM CONSOLIDATION TEST (CASAGRANDE PROCEDURE)
 ○ PRECONSOLIDATION PRESSURE FROM CONSOLIDATION TEST (CASAGRANDE PROCEDURE - SAMPLES BELIEVED TO BE RELATIVELY DISTURBED)

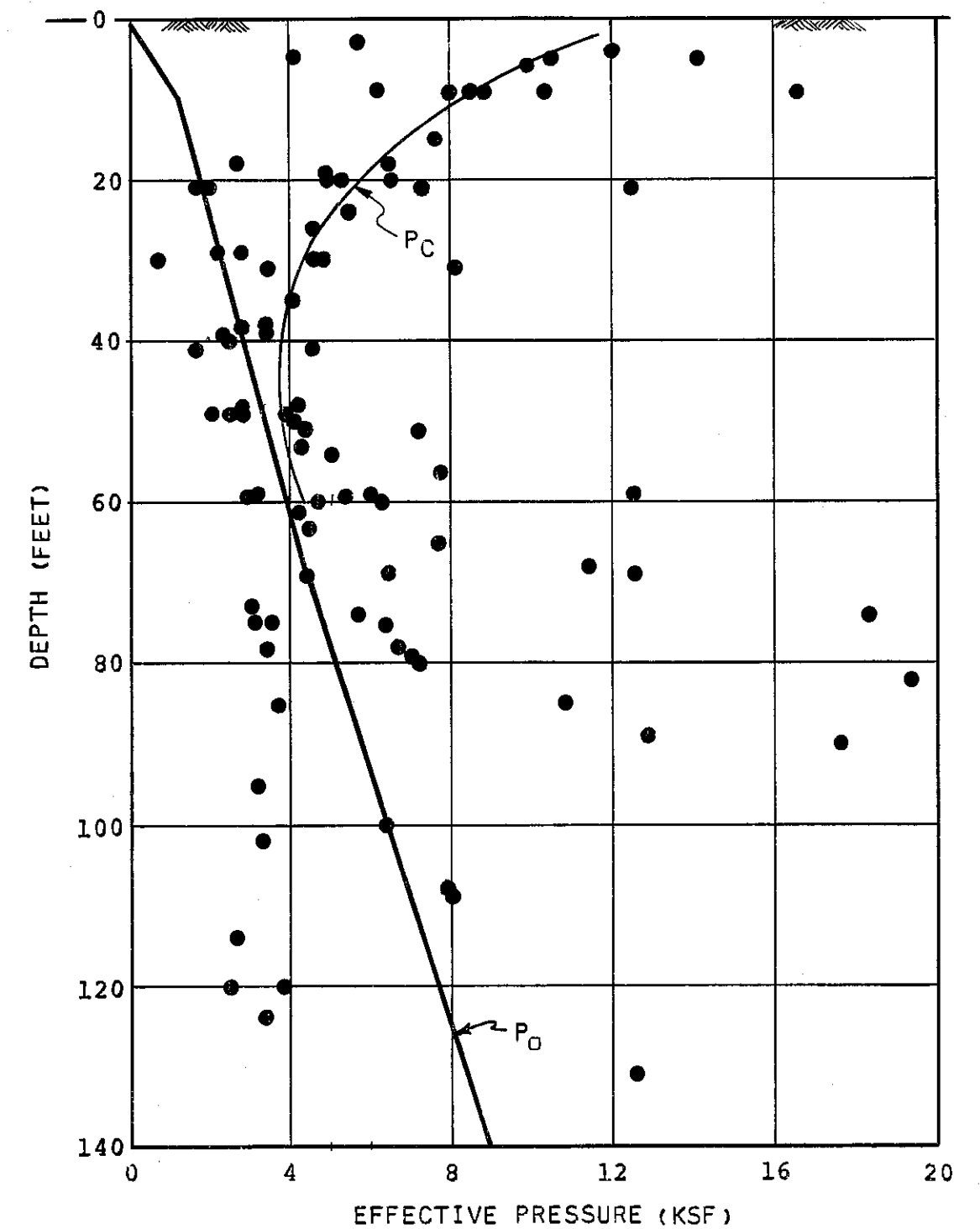
SOIL DATA

DEPTH (FT)	TOTAL UNIT WEIGHT (PCF)	EFFECTIVE UNIT WEIGHT (PCF)
0-20	125	63
20-50	115	53
50+	125	63

LEGEND

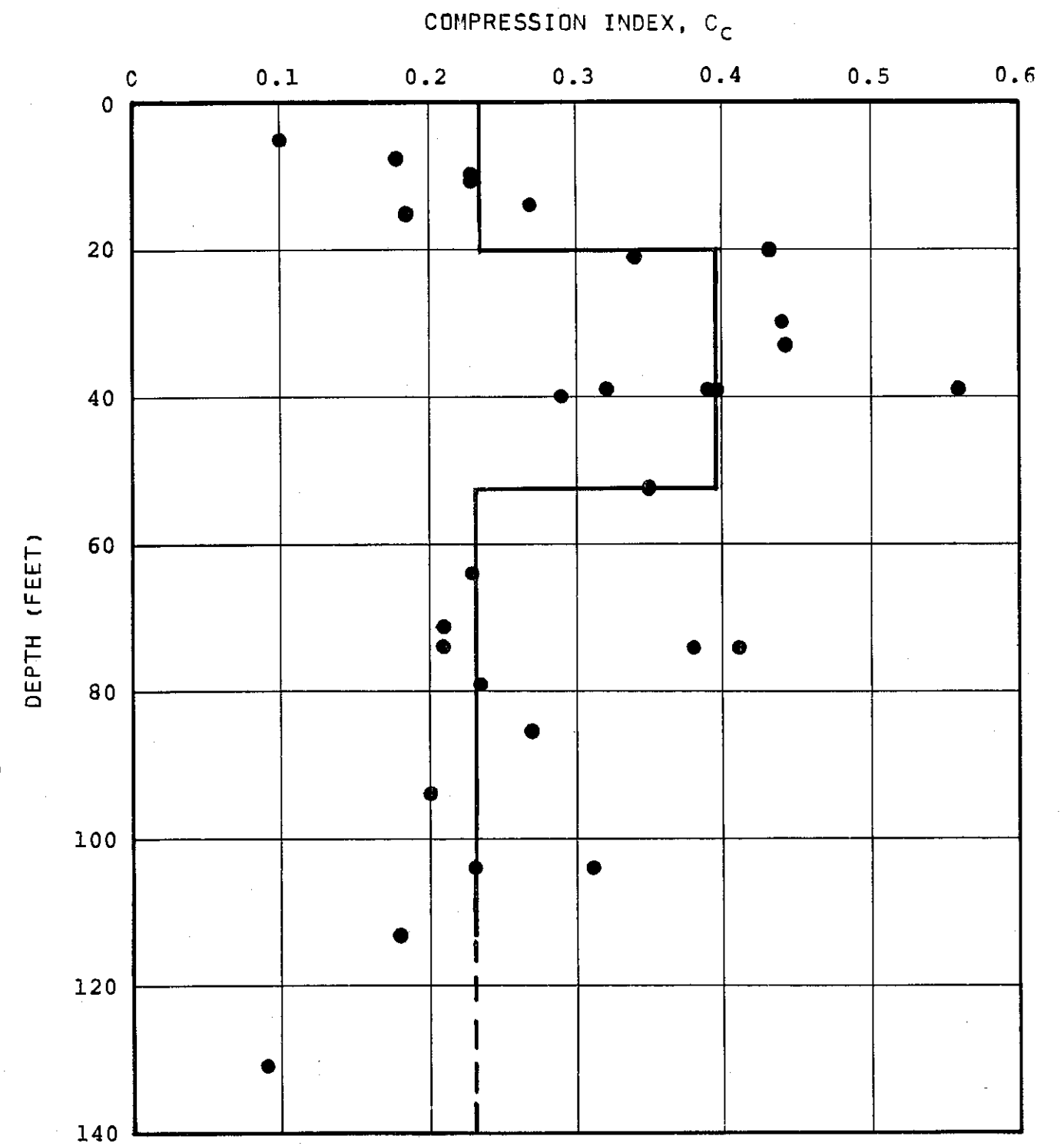
- EFFECTIVE OVERBURDEN PRESSURE WITH WATER TABLE AT 10 FOOT DEPTH
- EFFECTIVE OVERBURDEN PRESSURE WITH WATER TABLE AT 20 FOOT DEPTH
- DESIGN PRECONSOLIDATION PRESSURE


BECHTEL ANN ARBOR			
BELLE RIVER PLANT UNIT 1 & 2			
PRECONSOLIDATION PRESSURE VS DEPTH			
	JOB NO.	DRAWING NO.	REV.
	10539	FIGURE 32	○

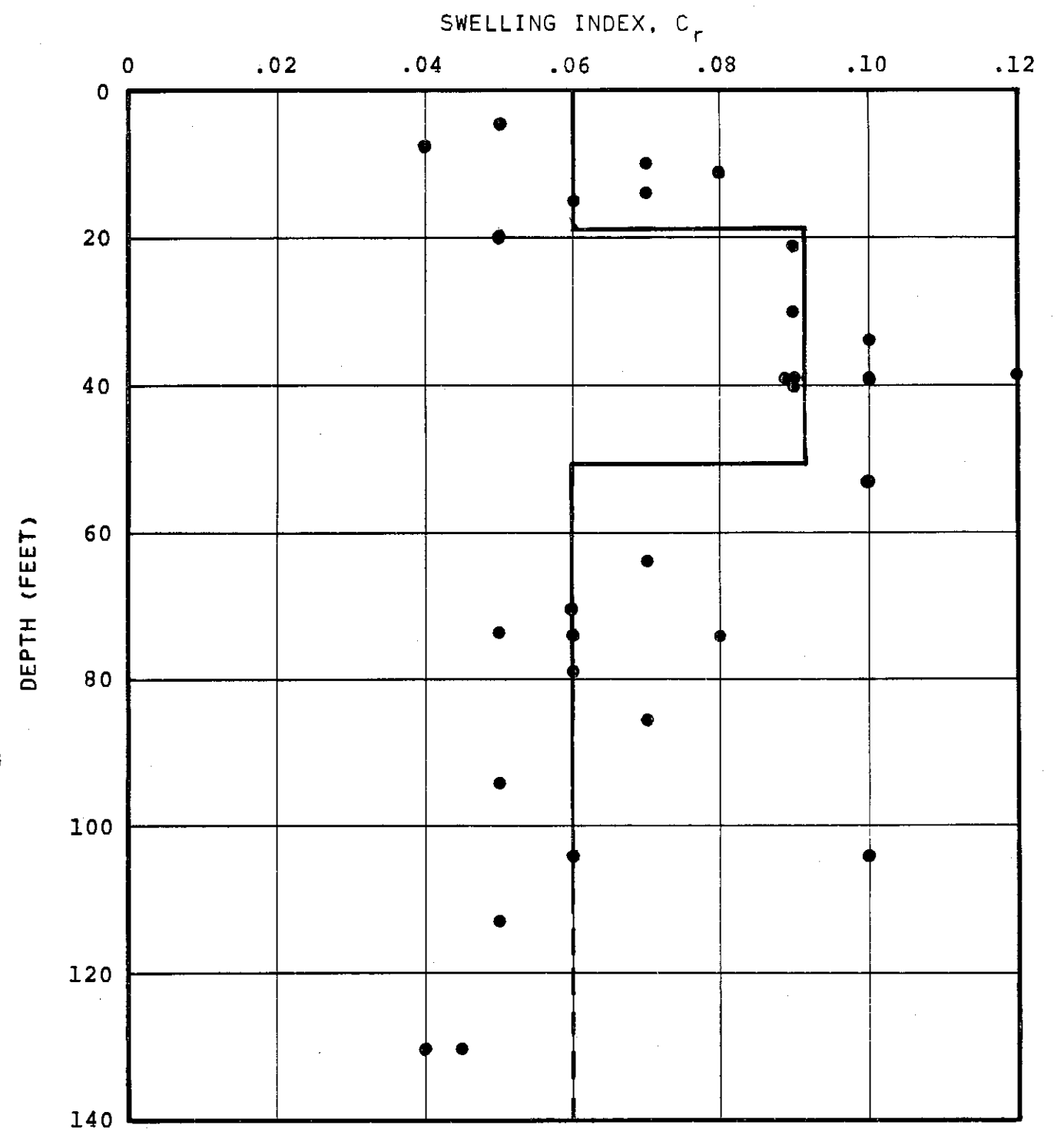


NOTE: COHESION (C) FROM UU & QU TESTS SUBSTITUTED FOR "C"
 IN SKEMPTON'S RELATIONSHIP $C/\bar{p} = 0.11 + .0037 \times P_1$.

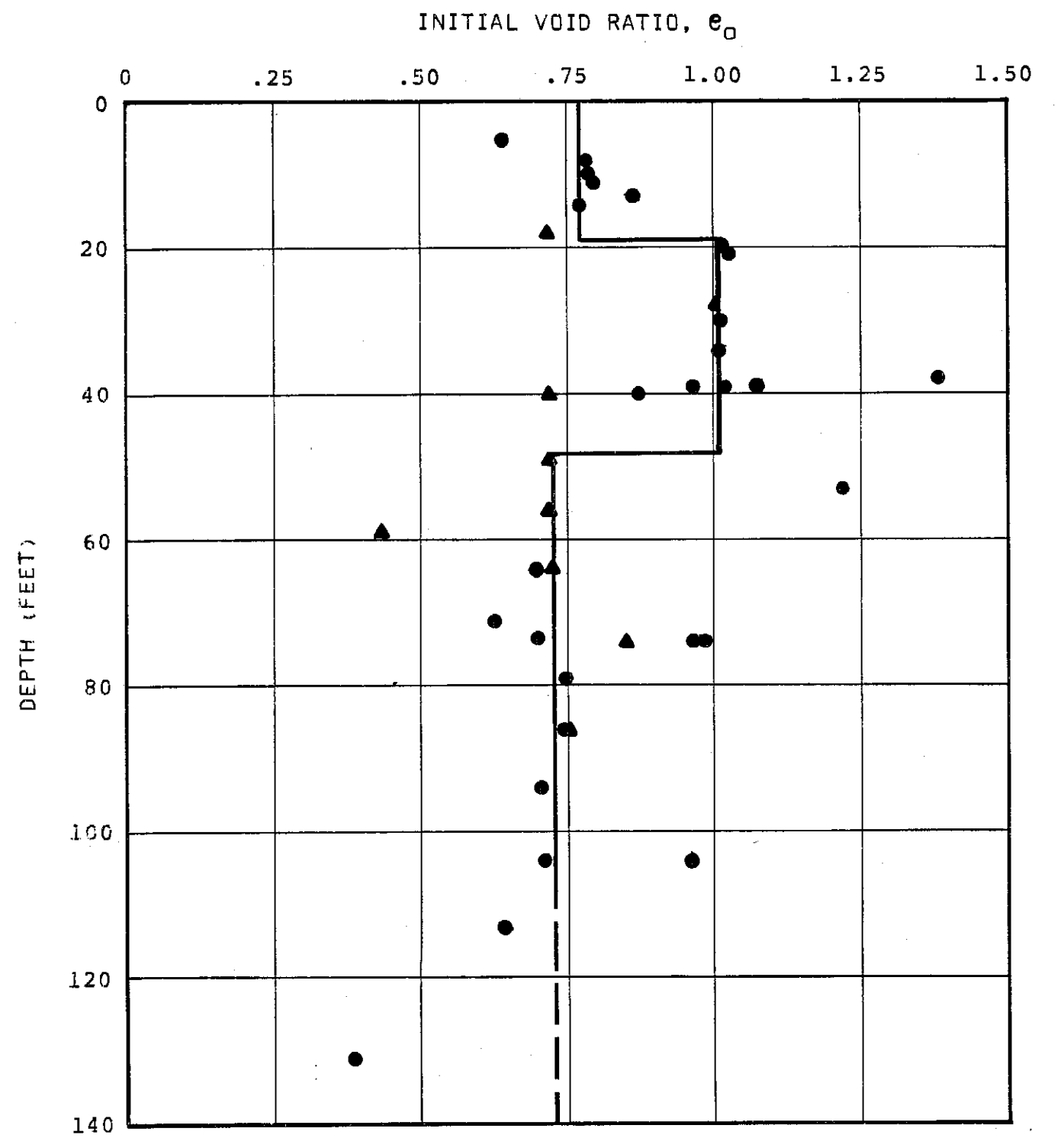
BECHTEL ANN ARBOR			
BELLE RIVER PLANT UNITS 1 & 2			
P_c OBTAINED FROM SKEMPTON'S RELATIONSHIP			
JOB No.	DRAWING No.		REV.
	10539	FIGURE 33	



BECHTEL ANN ARBOR			
BELLE RIVER PLANT UNITS 1 & 2			
COMPRESSION INDEX VS DEPTH			
	JOB No.	DRAWING No.	REV
	10539	FIGURE 34	B



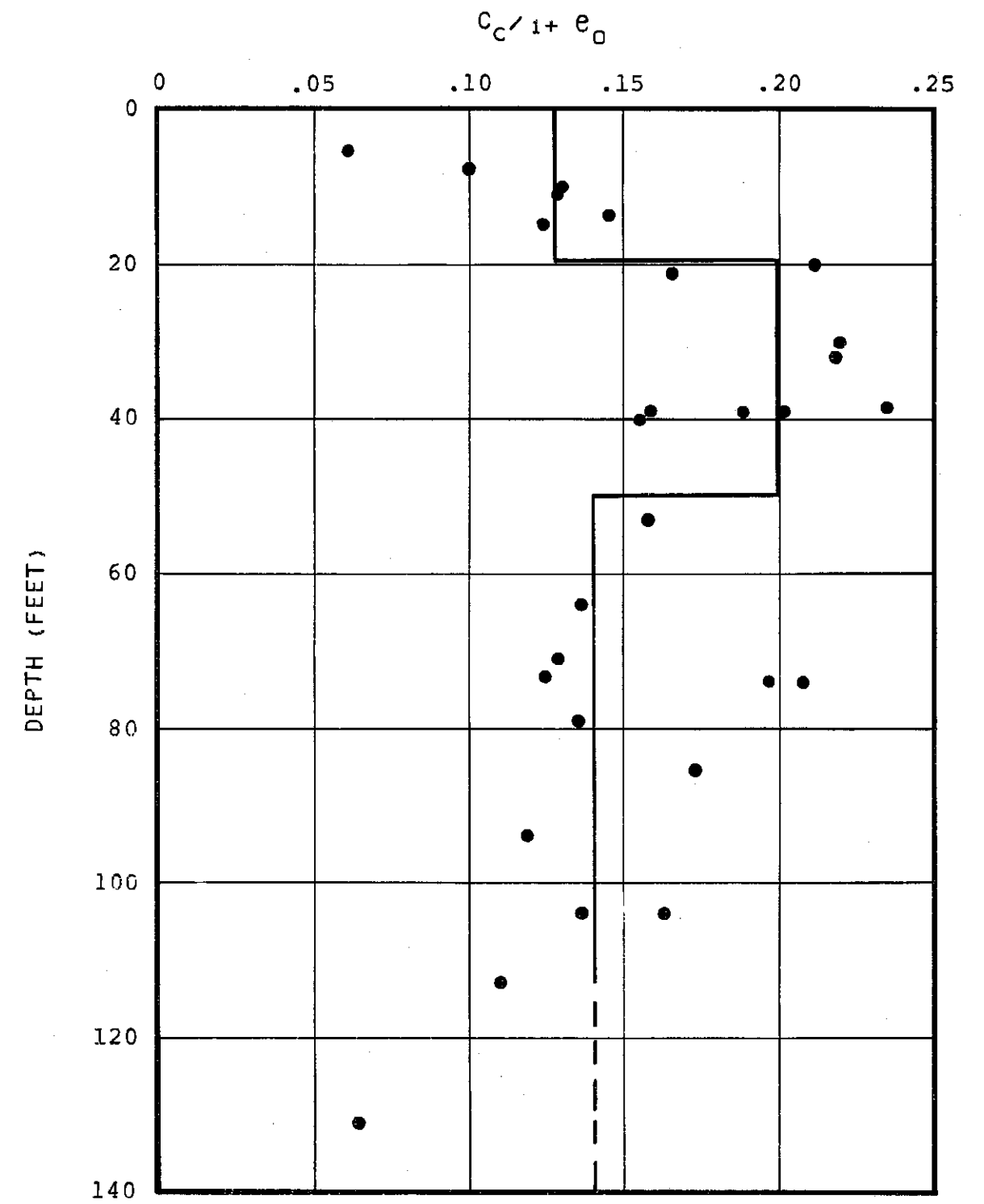
BECHTEL ANN ARBOR			
BELLE RIVER PLANT UNITS 1 & 2			
SWELLING INDEX vs DEPTH			
	JOB No.	DRAWING No.	REV.
	10539	FIGURE 35	B



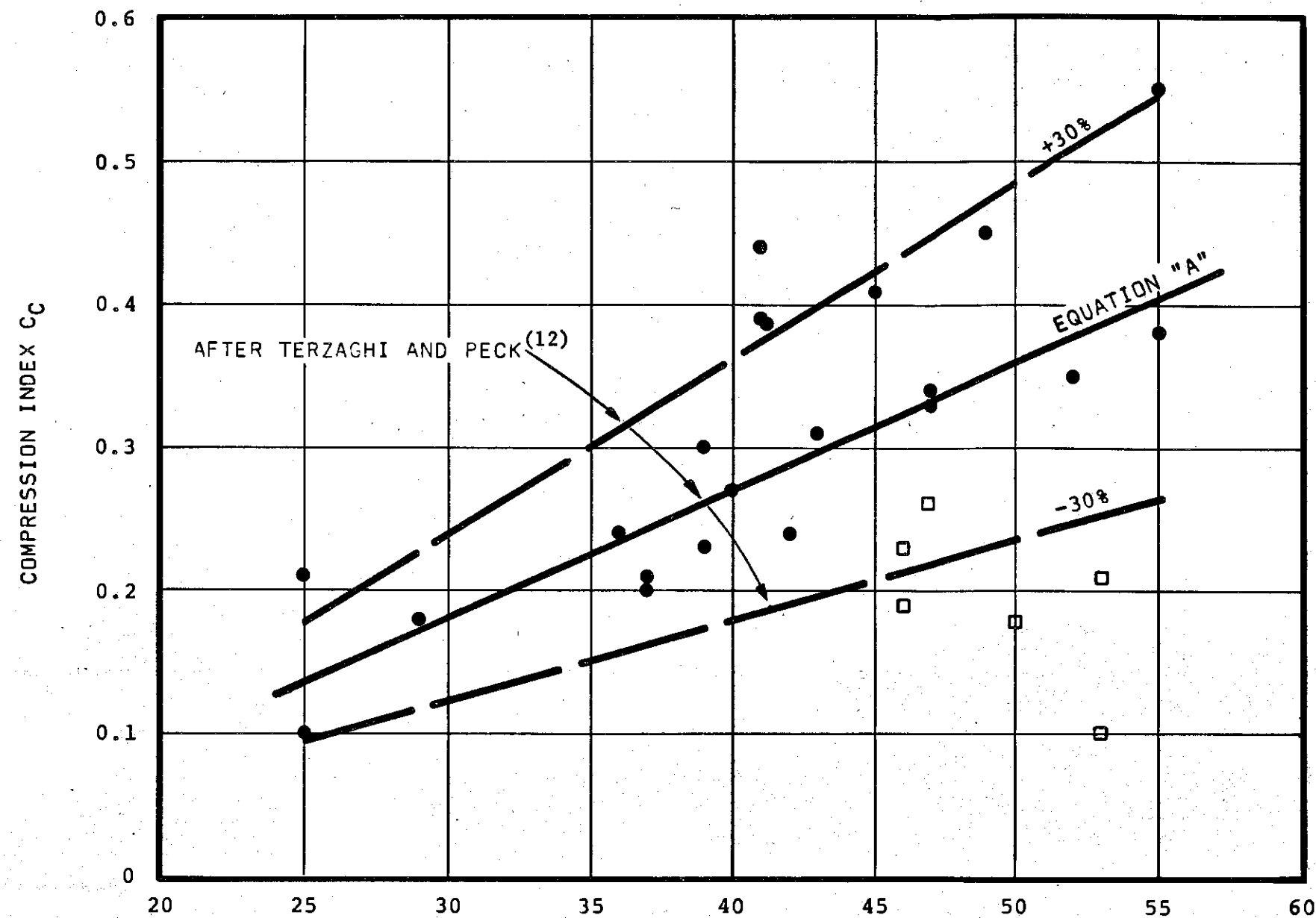
LEGEND

- FROM CONSOLIDATION TEST RESULTS
- ▲ FROM PERMEABILITY TEST RESULTS

BEGTEL ANN ARBOR			
BELLE RIVER PLANT UNITS 1 & 2			
INITIAL VOID RATIO VS DEPTH			
	JOB No. 10539	DRAWING No. FIGURE 36	REV. e



BECHTEL ANN ARBOR		
BELLE RIVER PLANT UNITS 1 & 2		
SETTLEMENT PARAMETER $C_c / 1 + e_0$ VS DEPTH		
JOB No.	DRAWING No.	REV.
10539	FIGURE 37	B



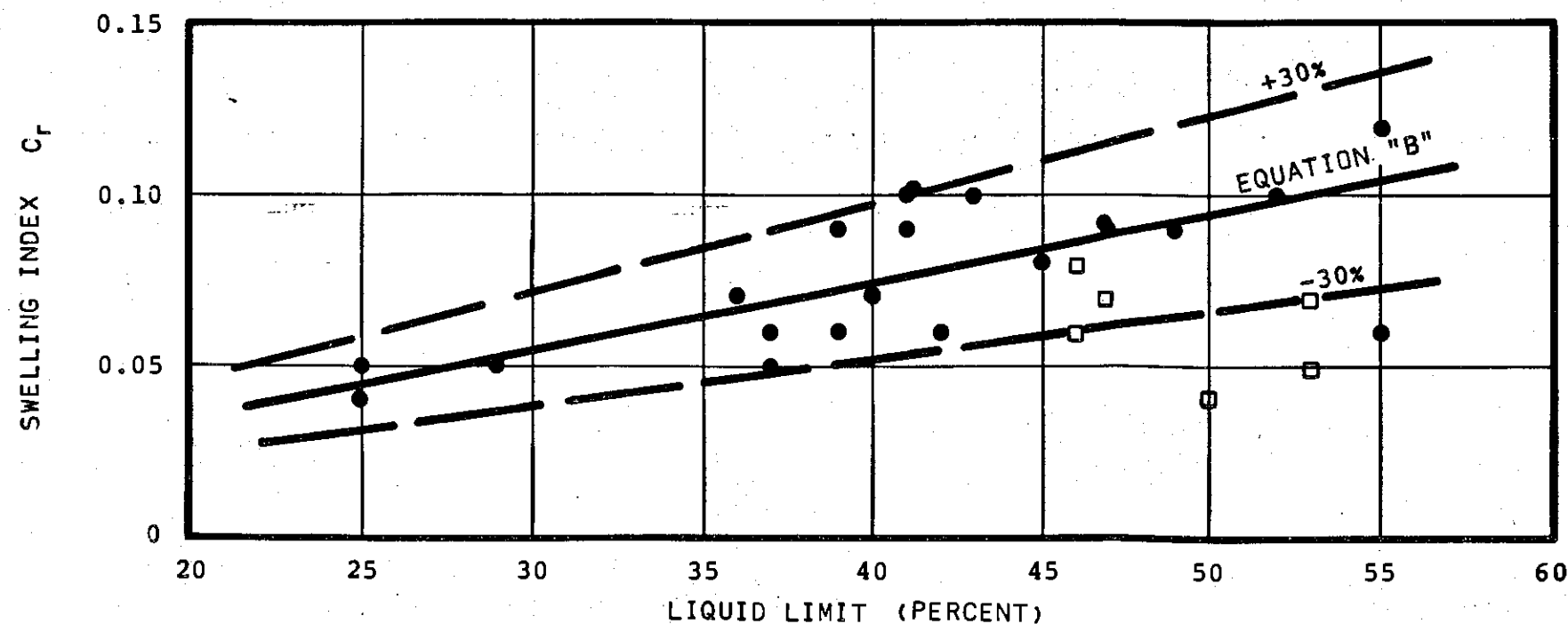
NOTES:

- UPPER STRATUM (0-20 FEET) OVERCONSOLIDATION RATIO GREATER THAN 4.
- MIDDLE AND LOWER STRATA (BELOW 20 FEET) OVERCONSOLIDATION RATIO LESS THAN 2.

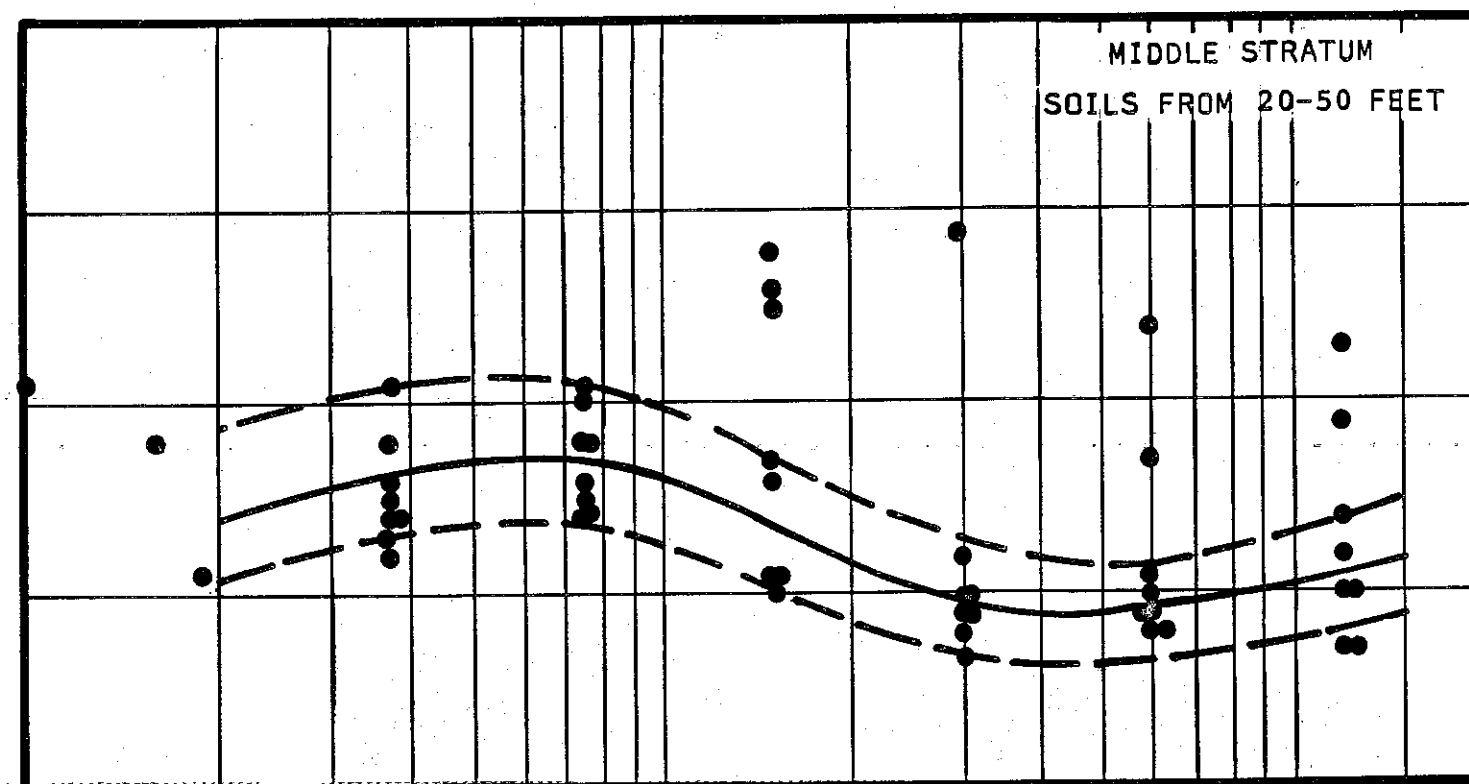
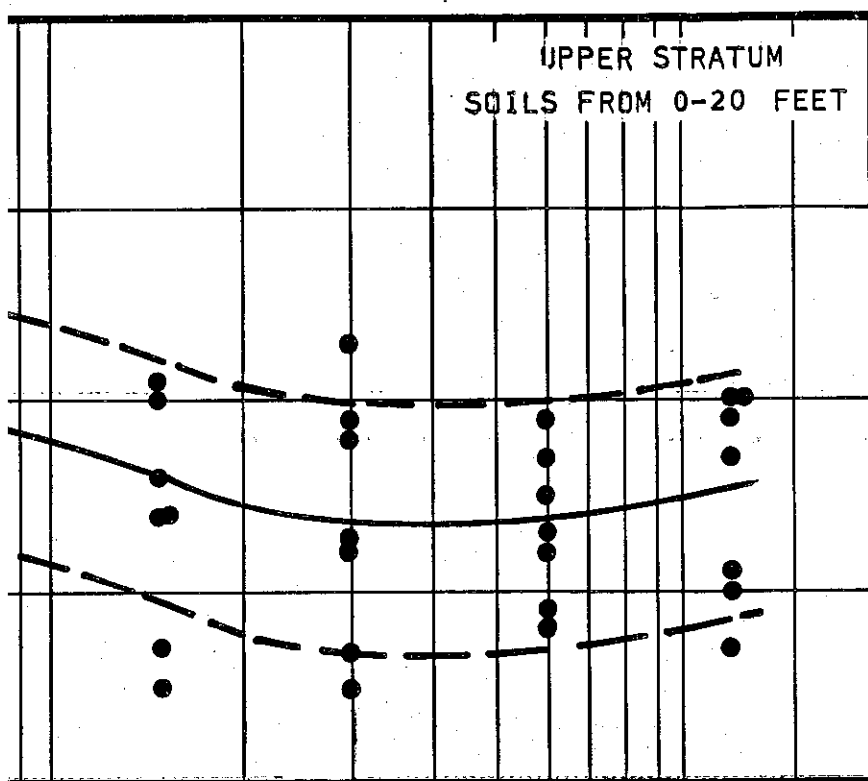
EXPLANATION

EQUATION "A" — COMPRESSION INDEX
 $C_c = 0.009(LL-10)$

EQUATION "B" — SWELLING INDEX
 $C_r = 0.002(LL-2.5)$



BECHTEL			
ANN ARBOR			
BELLE RIVER PLANT			
UNIT 1 & 2			
LIQUID LIMIT vs COMPRESSION AND SWELLING INDICIES			
BECHTEL	JOB NO.	DRAWING NO.	REV.
	10539	FIGURE 38	0

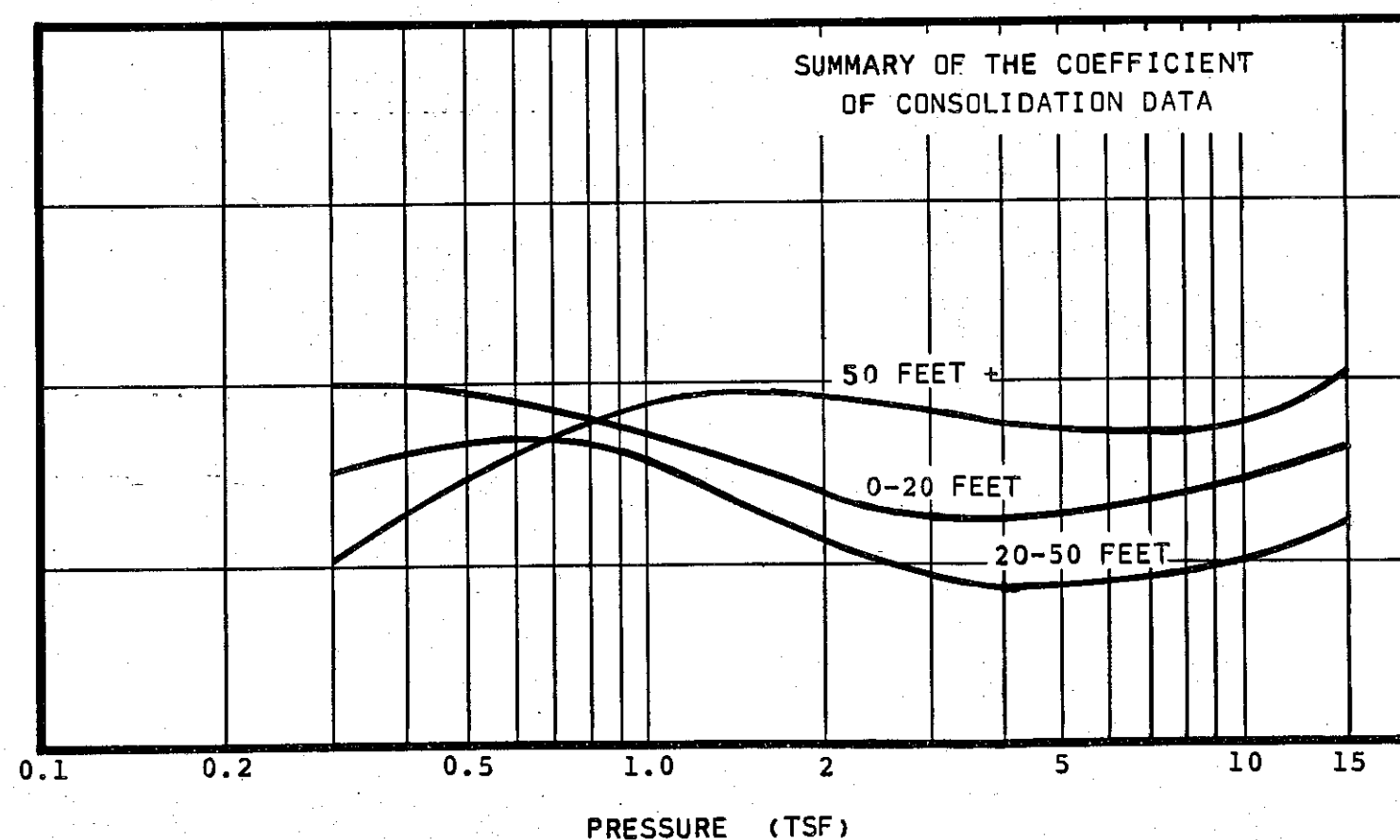
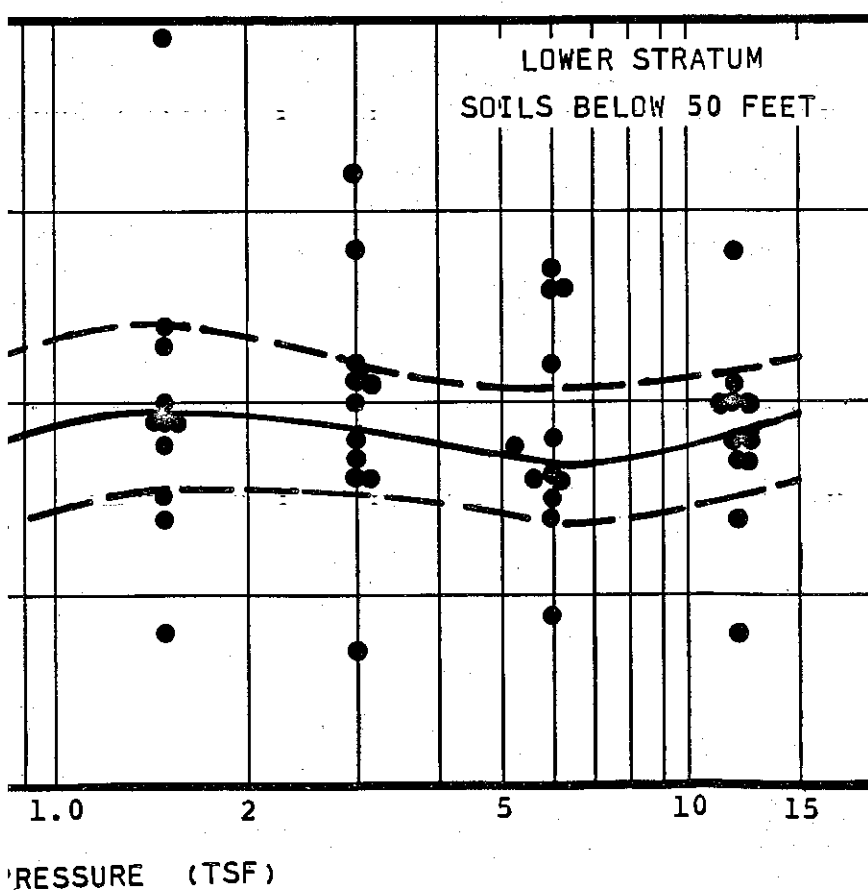


NOTE:

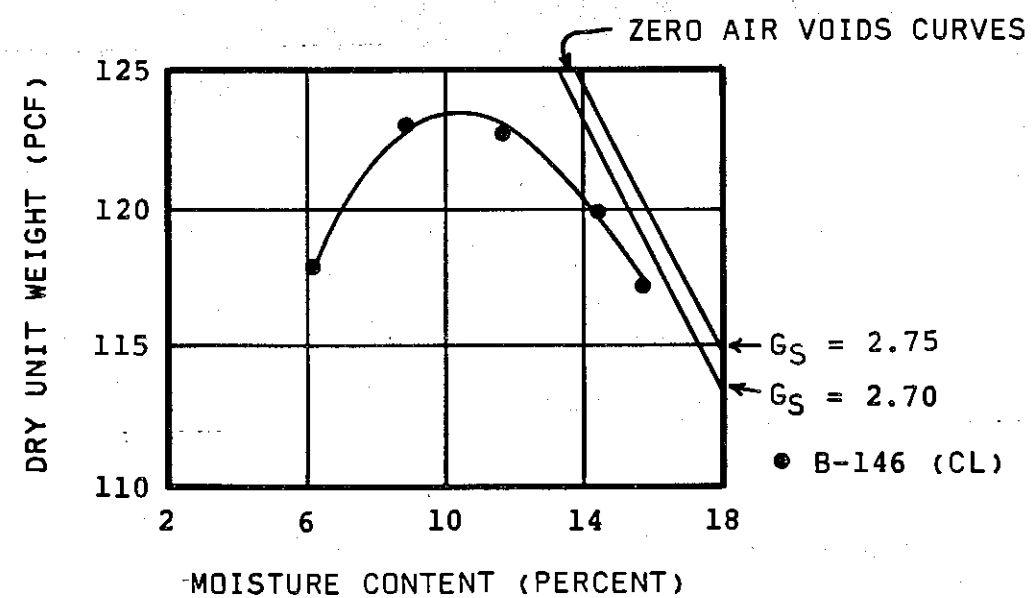
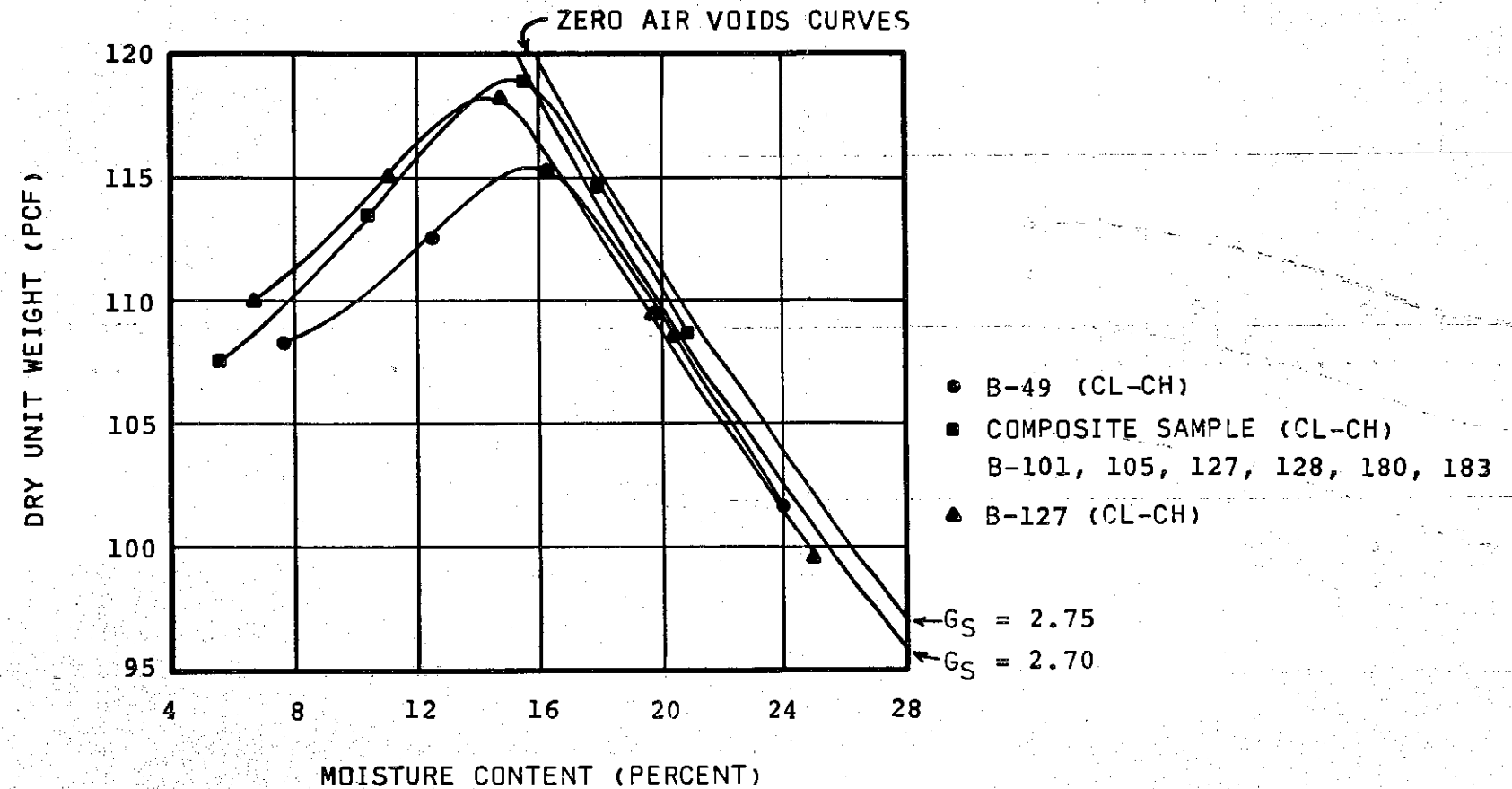
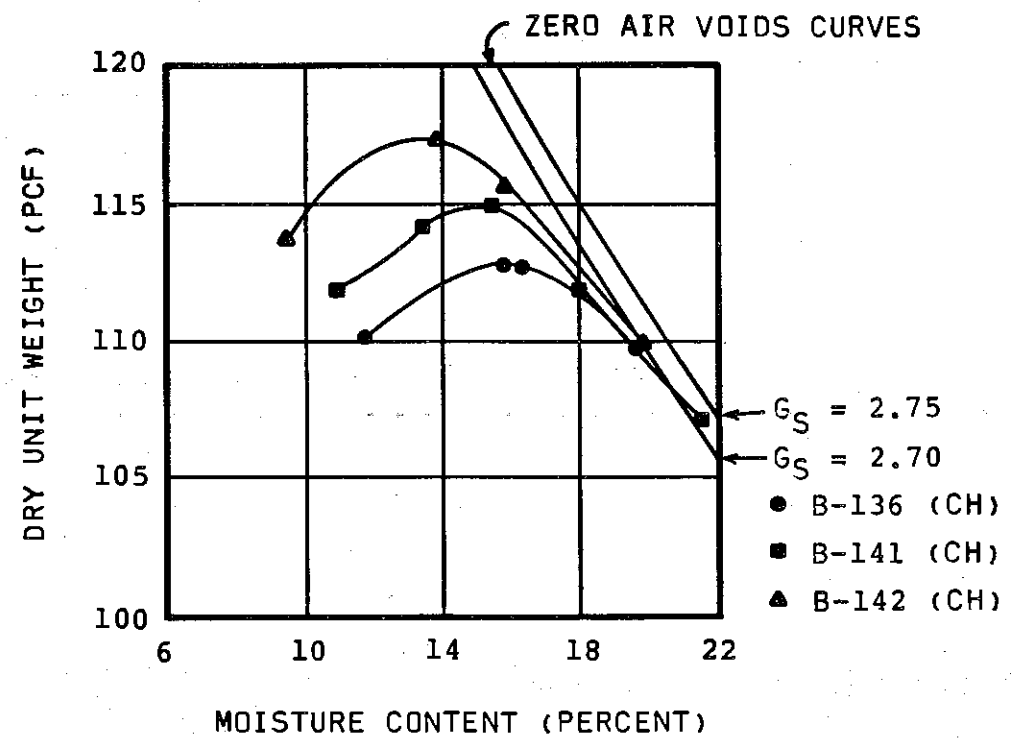
COEFFICIENT OF CONSOLIDATION BASED
ON THE SQUARE ROOT OF TIME METHOD.

EXPLANATION:

--- RANGE OF VALUES
— DESIGN CURVE



BECHTEL ANN ARBOR		
BELLE RIVER PLANT UNIT 1 & 2		
COEFFICIENT OF CONSOLIDATION VS PRESSURE		
	JOB NO.	DRAWING NO.
	10539	FIGURE 39
	REV.	○



NOTES:

- 1) ALL TESTS WERE MADE ACCORDING TO ASTM D-1557 METHOD C.
- 2) THE ZERO AIR VOIDS CURVES HAVE BEEN DRAWN FOR ASSUMED SPECIFIC GRAVITY (G_s) OF 2.70 AND 2.75.

BECHTEL ANN ARBOR		
BELLE RIVER PLANT UNITS 1 & 2		
SUMMARY OF COMPACTION TESTS UPPER STRATA SOILS		
JOB NO.	DRAWING NO.	REV.
10539	FIGURE 40	0

Appendix A

P. O. Box 619
Ann Arbor, Michigan 48107
April 5, 1966

Mr. Joseph Funston
The Detroit Edison Company
Room 604 S.B.
2000 Second Avenue
Detroit 26, Michigan

Re: Soil Investigation at the St. Clair Power Plant

Dear Mr. Funston:

Enclosed you will find two sets of the results of the soil investigation made in connection with the extension of Unit No. 7 and the yard's conveyor area.

Each set includes the individual boring log profile of the 1965 borings (22, 25, and 27), followed by two Composite Subsoil Analysis Profiles. One composite is for the Power House Area. Here, superimposed on the composite chart of the 1965 borings, are both the transverse and compression shearing resistances, together with the ASTM standard penetration values from the 1950 borings. Similarly, the soil investigation results from the 1950 borings (13, 14, 15, and 16) are superimposed on the second composite for the yard's conveyor area. Shown on these two composites are three averages for the shear and penetration values. Dotted lines represent the 1965 borings, red lines the 1950 borings, and heavy lines the average of all borings.

As seen on the two composites, a comparison of the soil resistances of the soil strata encountered between the 1950 and 1965 borings is rather clear. However, two tables were prepared to facilitate reference to such comparison. In general, the soil resistances measured in the 1965 borings are lower than those of the 1950 borings, with few exceptions occurring at the lower strata. However, the averages from all borings which are recommended as design values, are closer to the 1965 borings.

It should not be overlooked that the shear values from the 1965 borings are available only from Borings 22 and 25 for one area, and only

Mr. Joseph Funston
The Detroit Edison Company
Detroit 26, Michigan

April 5, 1966
Page Two

Boring 27 for the other area. For this reason, only few values were available in each stratum, and the 1965 average alone should not be considered as representative of the area involved. Because more penetration values are available from all of the 1965 borings, the averages are now more representative and closer to the averages of both the 1950 and 1965 borings. A more detailed report of this investigation will be prepared if desired.

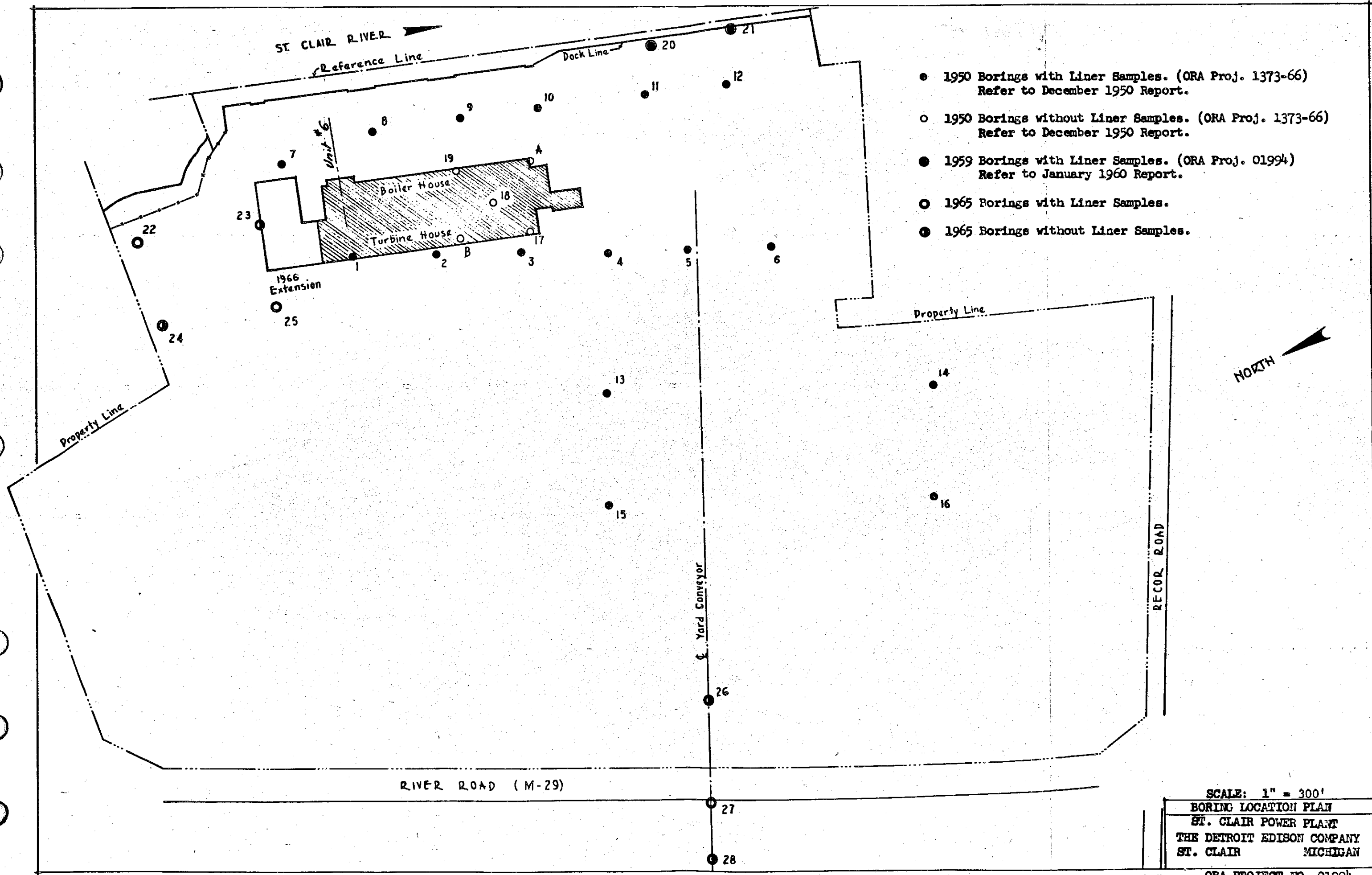
Very truly yours,

Georges Salin
For W. S. Housel

CS:kd
Enclosures

cc: Mr. Robert A. Briggs

SOIL INVESTIGATION AT
ST. CLAIR POWER PLANT
THE DETROIT EDISON COMPANY



COMPARISON OF AVERAGE SOIL RESISTANCES BETWEEN
1950 AND 1965 BORINGS IN THE POWER PLANT AREA
ST. CLAIR POWER PLANT

1950 Borings: 1 through 12, 17, 18, and 19
1965 Borings: 22, 23, 24, and 25

Soil Type	S _c PSF			S _{uc} /4 PSF			N Blows/Ft.			Elev. Ft.
	1 1950	2 1965	1 & 2 All	1 1950	2 1965	1 & 2 All	3 1950	4 1965	3 & 4 All	
591 Ground Surface										591
Medium to stiff vari-colored clay, trace of gravel.	1500	*	1364	1167	*	1142	14.7	12.8	14.1	577
577										
	130	123	151	221	112	201	4.1	2.8	3.9	560
Very soft brown-gray clay, trace to some sand.	555	90	106	118	81	111	2.5	1.8	2.3	545
	100	*	154	140	*	137	3.5	3.3	3.2	535
535										
		142	168	186	124	175	4.9	4.2	4.8	
							12.8	17.3	14.7	515
		122	143	155	155	155	6.4	7.3	6.6	500
Medium sandy gray clay, trace to some gravel.	150	167	172	201	168	195	7.5	8.1	7.7	480
		159	158	151	149	151	7.8	7.4	7.7	465
465										
	458									

(1) Based on shear test from Borings 1 through 12 only.

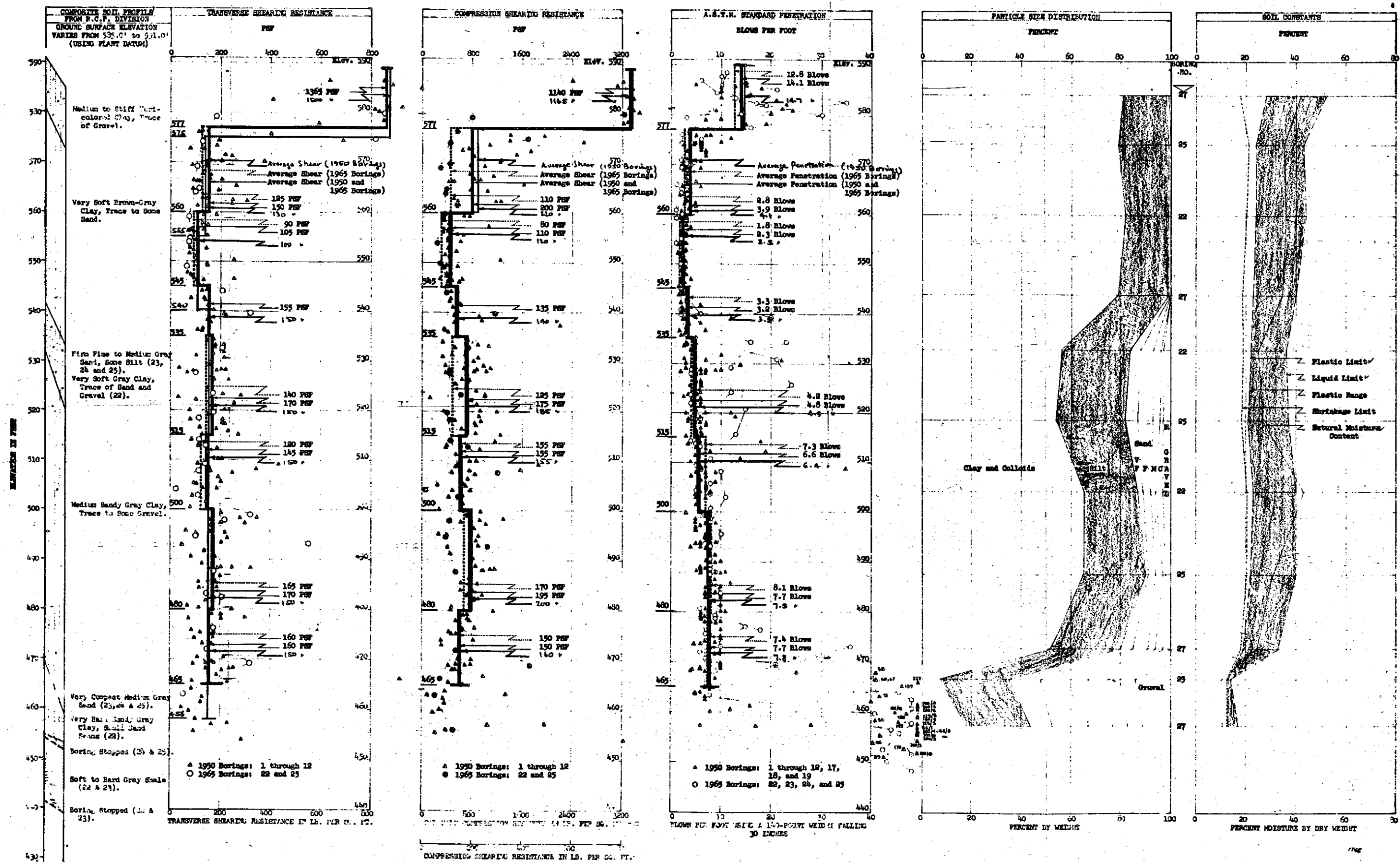
(2) Based on shear test from Borings 22 and 25 only.

(3) Based on ASTM penetration from Borings 1 through 12, 17, 18 and 19.

(4) Based on ASTM penetration from Borings 22 through 25.

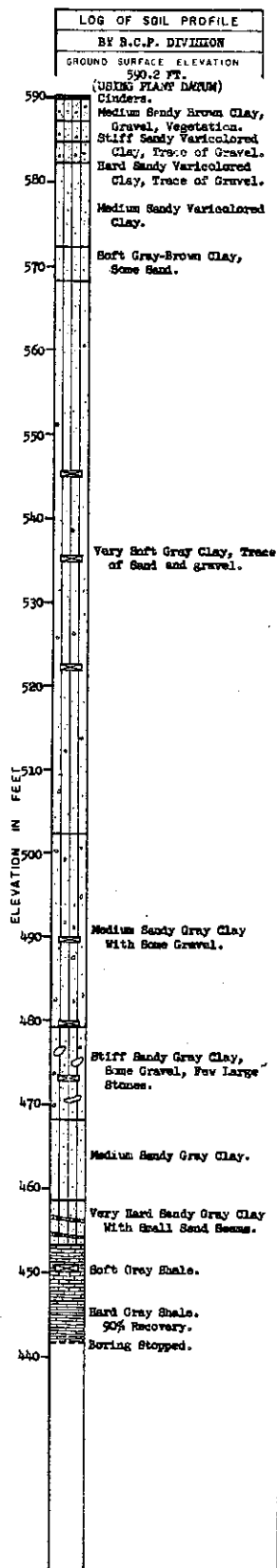
* Only one or two samples available.

□ Represent ASTM penetration for the sand layer found in variable thickness in Borings 1, 2, 3, 4, 17, 19, 23, 24, and 25 only between Elevs. 540 and 510.

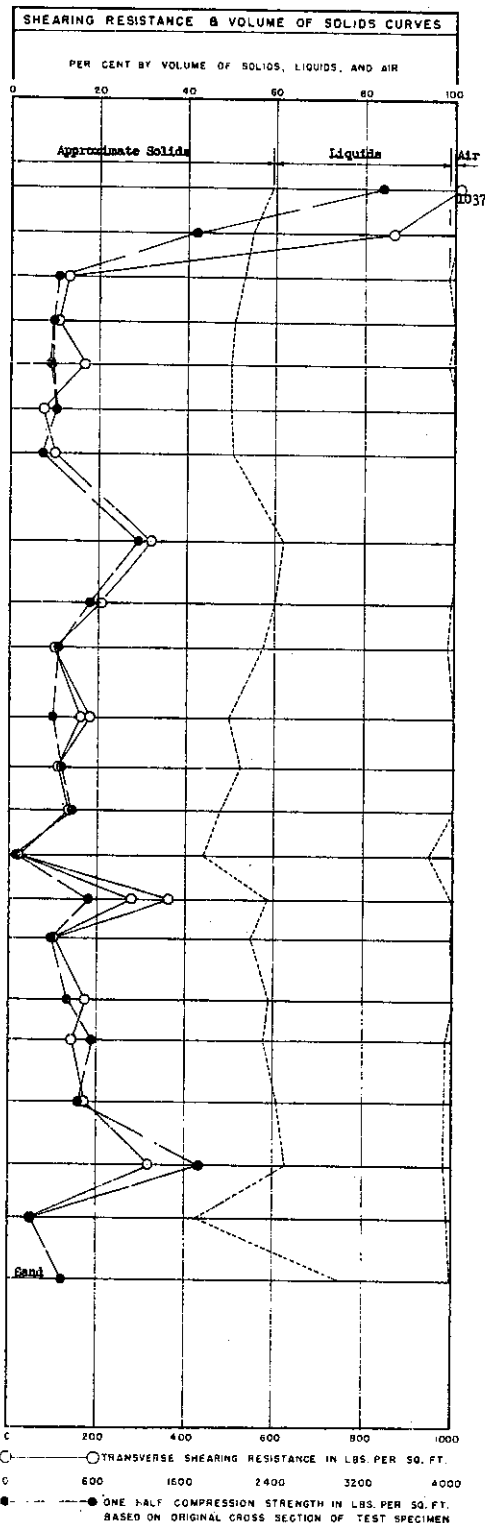


The above Composite Soil Profile is intended only to present average conditions throughout the group of borings represented. See individual Boring Charts for details.

OFFICE OF RESEARCH ADMINISTRATION
SOIL MECHANICS LABORATORY
UNIVERSITY OF MICHIGAN ANN ARBOR, MICHIGAN
COMPOSITE SURFACE ANALYSIS OF BORINGS NO. 22, 23, 24, 25
ST. CLAIR POWER PLANT
THE DETROIT EDISON COMPANY
APPROVED: *W. H. Howell* DATE: 4-5-1966 PROJECT: 01994



SOIL SAMPLE						LABORATORY VISUAL INSPECTION	
SA NO.	ELEV.	LAB. CONG. TENCY	PENETRATION		% H ₂ O	DRY WT. LBS. PER CU. FT.	REMARKS
			NO. OF BLOWS	DRIVE IN INCHES	BY DRY WT.		
1-BS	587.7	--	10	12			
2-BS	585.2	--	21	12			
3-BS	582.7	--	35	12			
4-LS	580.2	Stiff	14	12	25.8	99.2	4-LS: Uniform. Silty brown-gray laminated clay, trace of gravel.
5-LS	575.2	Plastic to Firm	6	12	33.5	91.8	5-LS: Uniform. Silty brown-gray laminated clay.
6-LS	570.2	Soft	3	12	32.5	88.6	6-LS: Uniform. Gray clay, little silt.
7-LS	565.2	Very Soft	2	12	36.4	84.9	7-LS: Uniform. Gray clay, little silt.
8-LS	560.2	Very Soft	2	12	35.9	84.9	8-LS: Uniform. Gray clay, little silt.
9-LS	555.2	Very Soft	2	12	38.7	83.6	9-LS: Uniform. Gray clay, little silt.
10-LS	550.2	Very Soft	2	12	37.4	84.2	10-LS: Uniform. Gray clay, little silt.
	545.2	--	2	12			
11-LS	540.2	Plastic	6	12	23.9	102.3	11-LS: Uniform. Silty gray clay, trace of very fine sand and fine gravel.
	535.2	--	5	12			
12-LS	531.2	Soft	4	12	25.0	98.5	12-LS: Uniform. Silty gray clay, little sand and trace of fine gravel.
13-LS	528.2	Soft	4	12	27.5	94.2	13-LS: Uniform. Silty gray clay, little sand and trace of fine gravel.
	522.2	--	4	12			
14-LS	520.2	Soft	4	12	38.6	81.7	14-LS: Uniform. Silty gray clay, little sand and trace of fine gravel.
15-LS	515.7	Soft	4	12	34.6	86.1	15-LS: Uniform. Silty gray clay, little sand and trace of fine gravel.
16-LS	509.7	Soft	5	12	41.6	78.6	16-LS: Uniform. Silty gray clay, little sand and trace of fine gravel.
	504.7	Very Soft	5	12	43.1	73.6	17-LS: Uniform. Silty gray clay, little sand and trace of fine gravel.
18-LS	499.7	Plastic	6	12	26.3	98.0	18-LS: Uniform. Silty gray clay, little sand and trace of fine gravel.
19-LS	495.2	Soft	7	12	30.5	91.7	19-LS: Uniform. Silty gray clay, little sand and trace of fine gravel.
	489.7	--	8	12			
20-LS	488.2	Soft	9	12	26.1	98.6	20-LS: Uniform. Silty gray clay, little sand and trace of fine gravel.
21-LS	483.7	Soft	10	12	26.4	96.7	21-LS: Uniform. Silty gray clay, little sand and trace of fine gravel.
	479.7	--	9	12			
22-LS	476.7	Soft	18	12	23.0	101.7	22-LS: Uniform. Silty gray clay, little sand and trace of fine gravel.
	473.2	--	36	12			
23-LS	469.7	Plastic	21	12	21.1	104.8	23-LS: Uniform. Silty gray clay, little sand and trace of fine gravel.
24-LS	463.7	Very Soft	8	12	49.8	71.1	24-LS: Uniform. Gray clay, some silt.
25-LS	455.7	Compact	117	12	12.1	126.0	25-LS: Uniform. Clayey coarse gray sand.
	450.2	--	100	12			
PENETRATION: Number of blows required to drive core sampler distance given using a 140-pound weight falling 30 inches.							



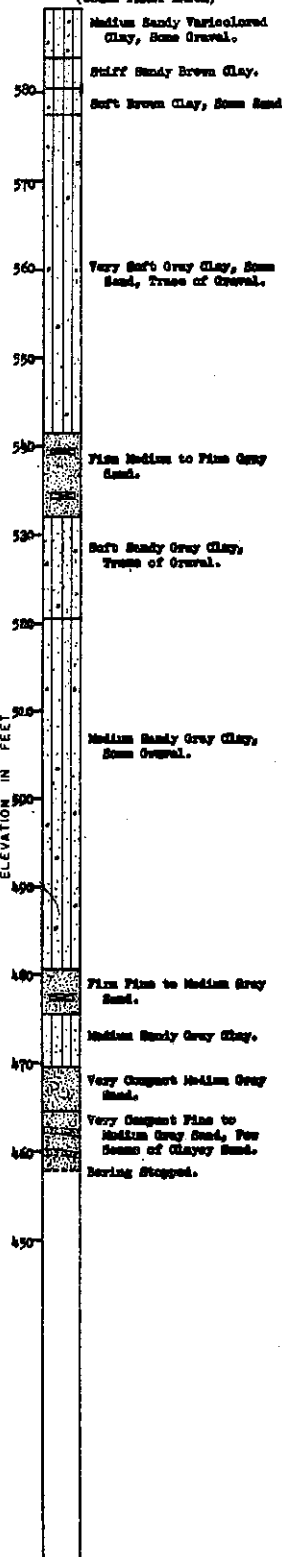
PENETRATION: Number of blows required to drive cone sampler distance given using a 140-pound weight falling 30 inches.

Failure to recover liner sample.

Boring log and all sampling by Raymond Concrete Pile Division of Raymond International, Inc. Their Job No. CB-4043-D Date of Boring: 7-31-1965

UNIVERSITY OF MICHIGAN RESEARCH INSTITUTE
SOIL MECHANICS LABORATORY
ANN ARBOR MICHIGAN
SUBSOIL ANALYSIS OF BORING NO. 22
ST. CLAIR POWER PLANT
THE DETROIT EDISON COMPANY ST. CLAIR, MICHIGAN
APPROVED: W. A. Housel DATE: 4-5-1966
PROJECT: 01994

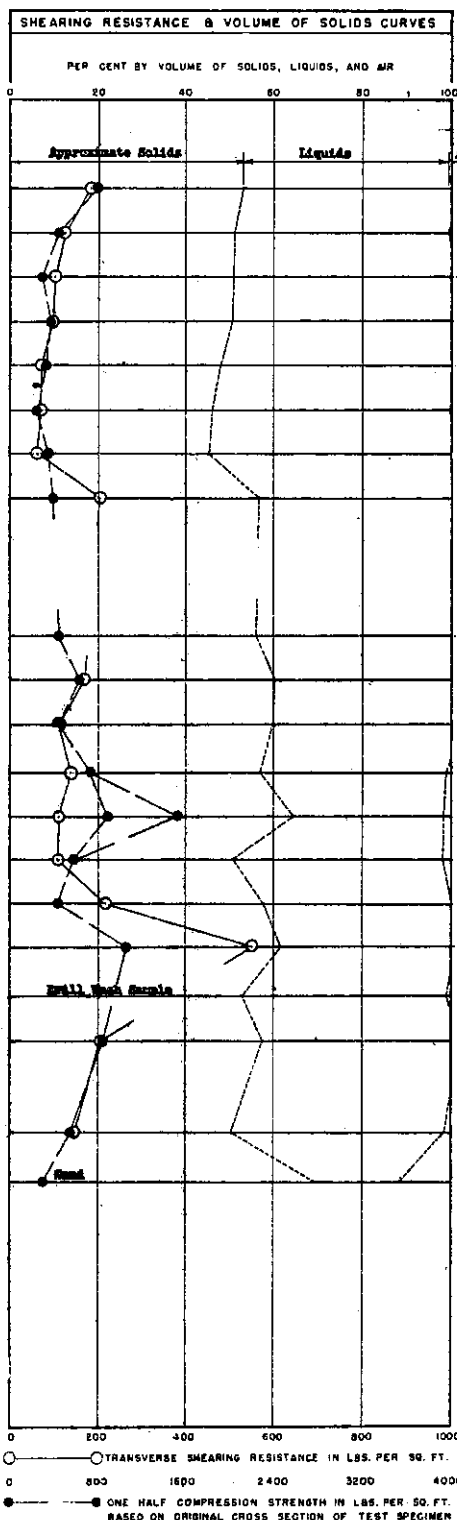
LOG OF SOIL PROFILE
BY R.O.P. DIVISION
GROUND SURFACE ELEVATION
569.5 FT.
(USING PLANT DATUM)



SA. NO.	ELEV.	LAB. CONSISTENCY	PENETRATION NO. OF DRIVE IN BLOWN INCHES	% H ₂ O DRY WT.	DRY WT. LBS. PER CU. FT.	REMARKS
1-28	587.0	—	6	18		
2-28	586.5	—	9	12		
3-28	586.0	—	18	12		
4-28	579.5	Soft	3	18	35.6	89.8
5-28	578.5	Very Soft	2	12	35.3	85.3
6-28	569.5	Very Soft	2	12	36.8	85.5
7-28	568.5	Very Soft	2	12	36.8	84.9
8-28	559.5	Very Soft	3	12	41.0	80.1
9-28	558.5	Very Soft	1	12	43.2	77.8
10-28	549.5	Very Soft	2	12	45.6	76.1
11-28	548.5	Soft	3	12	49.8	80.2
12-28	539.5	—	20	12		
13-28	538.5	—	24	12		
14-28	529.0	Soft	4	12	50.1	82.4
15-28	528.0	Soft	4	12	55.0	92.8
16-28	519.0	Soft	3	12	57.8	98.2
17-28	511.5	Soft to Plastic	6	12	62.1	93.6
18-28	508.5	Plastic	10	12	10.8	108.8
19-28	503.5	Soft	11	12	34.8	84.9
20-28	502.5	Soft	8	12	60.7	96.7
21-28	501.5	Plastic	8	12	81.9	—
22-28	500.0	Very Soft	8	12	31.0	80.8
23-28	503.0	Soft	8	12	68.4	96.7
24-28	477.5	—	22	12		
25-28	478.5	Soft	6	12	35.6	84.8
26-28	467.0	Loose	07	12	10.3	116.7
27-28	460.7	—	200	12		
28-28	458.0	—	200	12		

REMARKS: Number of blows required to drive two sampler distance given using a 140-pound weight falling 30 inches.

Failure to recover liner sample.



UNIVERSITY OF MICHIGAN RESEARCH INSTITUTE
SOIL MECHANICS LABORATORY
ANN ARBOR MICHIGAN
SUBSOIL ANALYSIS OF BORING NO. 25
ST. CLAIR POWER PLANT
THE DETROIT EDISON COMPANY ST. CLAIR, MICHIGAN
APPROVED: *W. A. Hornel* DATE: 4-5-1966
PROJECT: 01994

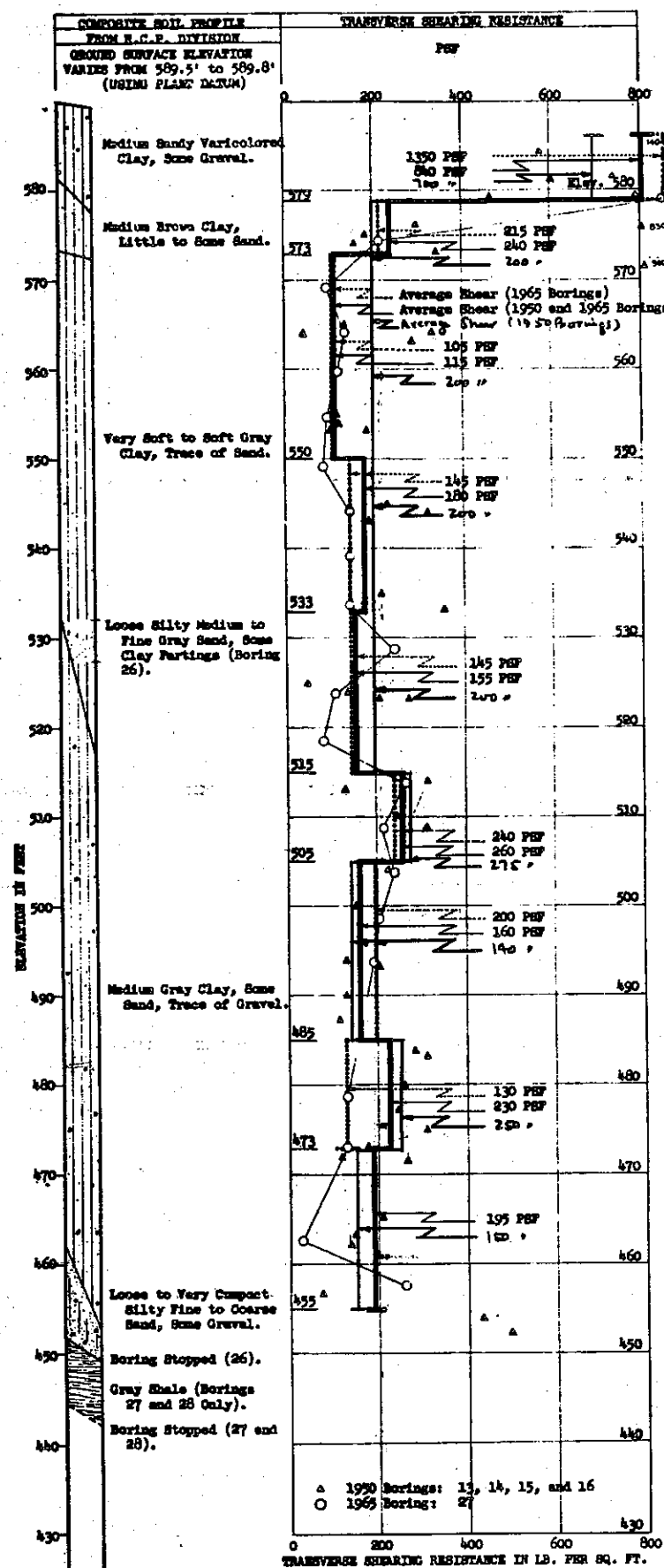
Boring log and all sampling by
Raymond Concrete Pile Division
of Raymond International, Inc.
Sheet Job No. CR-4043-D
Date of Boring: 7-1-1965

COMPARISON OF AVERAGE SOIL RESISTANCES BETWEEN
1950 AND 1965 BORINGS FOR THE YARD'S CONVEYOR
ST. CLAIR POWER PLANT

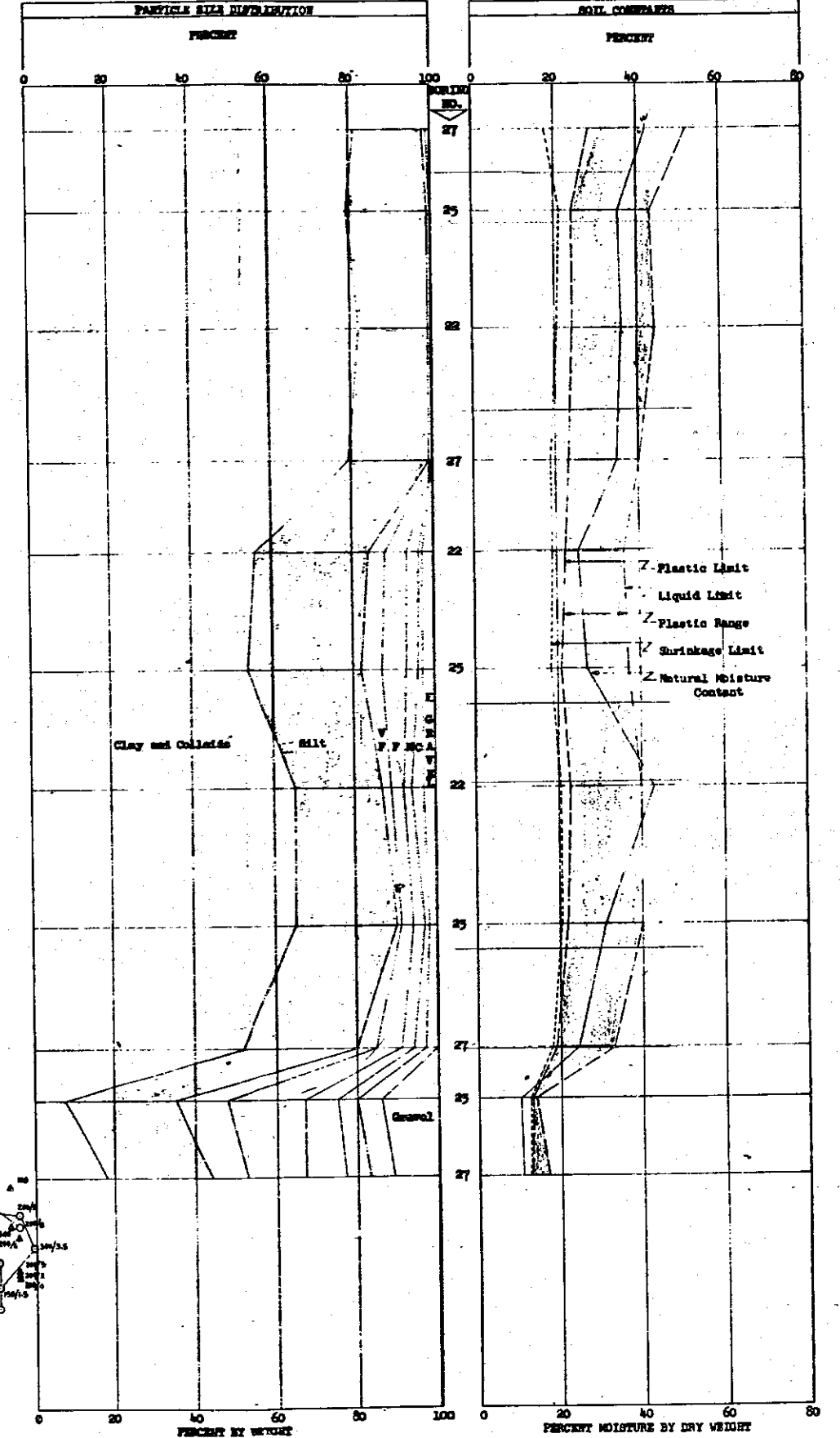
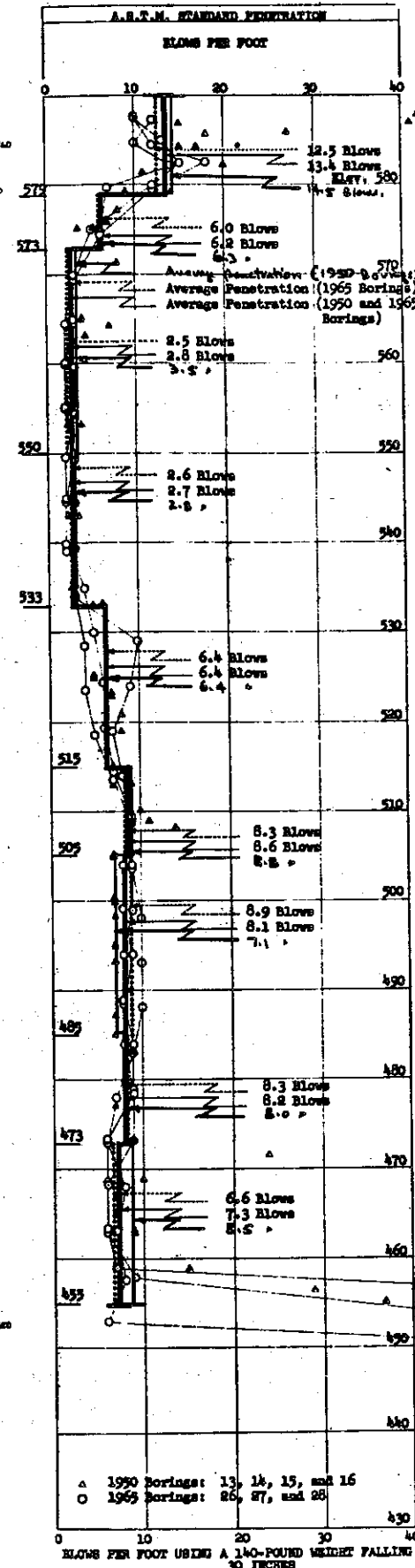
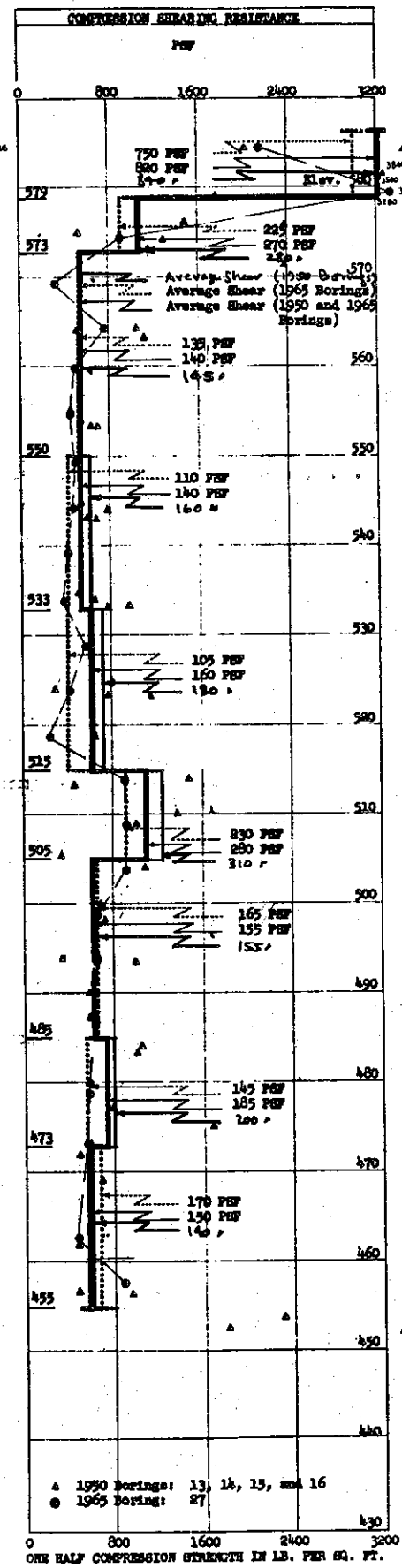
1950 Borings: 13, 14, 15, and 16
1965 Borings: 26, 27, and 28

Soil Type	S _c PSF			S _{uc} /4 PSF			N Blows/Ft.			Elev. Ft.
	¹ 1950	² 1965	^{1,2} All	¹ 1950	² 1965	^{1,2} All	¹ 1950	³ 1965	^{1,3} All	
590 Ground Surface										590
Medium sandy vari-colored clay, some gravel.	700	1350 ⁵	840	840	750 ⁵	818	14.5	12.5	13.4	579
579 Medium brown clay, little to some sand.	200	216 ⁴	241	280	226 ⁴	270	6.3	6.0	6.2	573
Very soft to soft gray clay, trace of sand.	200	106	116	144	136	142	3.5	2.5	2.8	550
	200	144	178	159	108	142	2.8	2.6	2.7	533
Medium gray clay, some sand, trace of gravel.	200	145	155	182	103	159	6.4	6.4	6.4	515
	275	240	260	312	232	278	8.8	8.3	8.6	505
	140	198 ⁵	161	154	165 ⁵	156	7.1	8.9	8.1	485
	250	130 ⁵	230	202	144 ⁵	185	8.0	8.3	8.2	473
	150	259 ⁴	195	140	170 ⁵	150	8.5	6.6	7.3	455

- (1) Based on shear tests and ASTM penetration values from Borings 13, 14, 15, and 16.
(2) Based on shear tests from Boring 27 only.
(3) Based on ASTM penetration values from Borings 26, 27, and 28.
(4) Based on one shear value only.
(5) Based on two shear values only.



The above Composite Soil Profile is intended only to present average conditions throughout the group of borings represented. See individual Boring Charts for details.

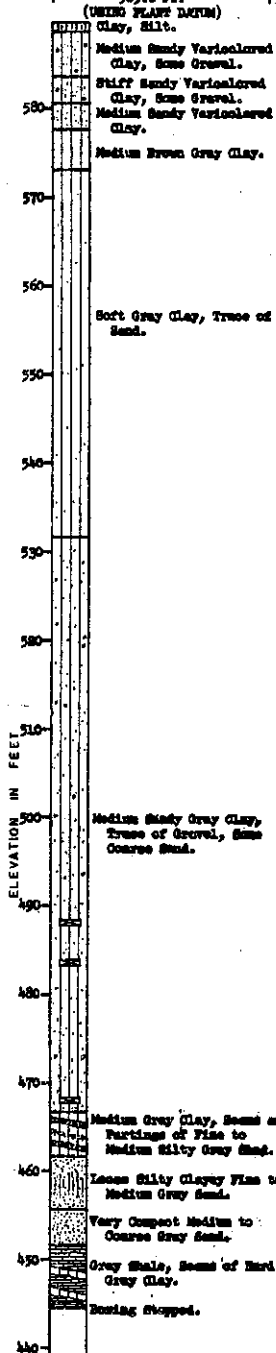


LOG OF SOIL PROFILE

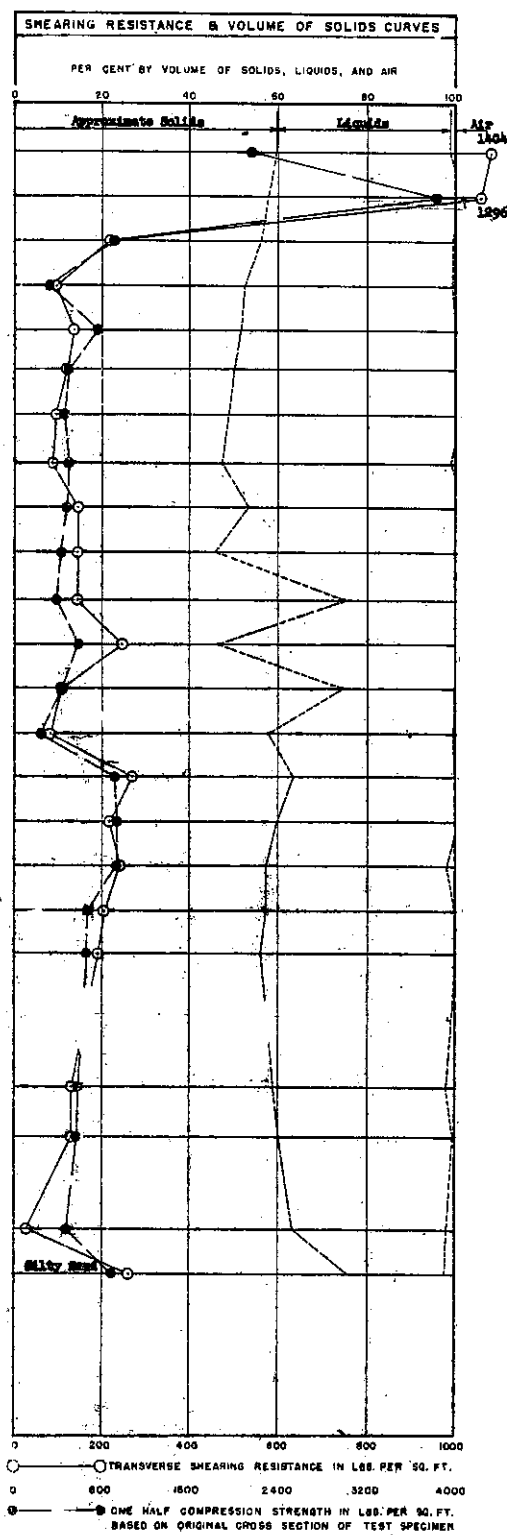
BY R.C.P. DIVISION

GROUND SURFACE ELEVATION 569.8 FT.

(USING PLANT DATUM)



SOIL SAMPLE						LABORATORY VISUAL INSPECTION
SA. NO.	ELEV.	LAB. CONSISTENCY	PENETRATION NO. OF BLOWS	% H ₂ O DRIVE IN INCHES	DRY WT. LBS. PER CU. FT.	REMARKS
1-18	567.3	—	10	12		1-18: Uniform. Brown-gray laminated clay, little silt, trace of sand.
2-18	564.3	Firm	12	12	64.6	2-18: Uniform. Brown-gray laminated clay, little silt, trace of sand.
3-18	562.3	—	10	12		3-18: Uniform. Brown-gray laminated clay, little silt, trace of sand.
4-18	572.3	Soft	12	12	66.3	4-18: Uniform. Brown-gray laminated clay, little silt, trace of sand.
5-18	574.3	Soft	6	12	66.8	5-18: Uniform. Brown-gray laminated clay, little silt, trace of sand.
6-18	569.3	Soft	1	12	33.1	6-18: Uniform. Gray clay, little silt, trace of sand.
7-18	568.3	Soft	2	12	34.8	7-18: Uniform. Gray clay, little silt, trace of sand.
8-18	558.8	Soft	2	12	30.0	8-18: Uniform. Gray clay, little silt, trace of sand.
9-18	554.8	Soft	2	12	30.0	9-18: Uniform. Gray clay, little silt, trace of sand.
10-18	548.3	Soft	3	12	30.7	10-18: Uniform. Gray clay, little silt, trace of sand.
11-18	544.3	Soft	3	12	34.7	11-18: Uniform. Gray clay, little silt, trace of sand.
12-18	539.3	Soft	3	12	34.0	12-18: Uniform. Gray clay, little silt, trace of sand.
13-18	533.8	Soft	3	12	32.6	13-18: Uniform. Silty gray clay, some pockets of fine sand.
14-18	528.8	Soft	12	12	35.0	14-18: Uniform. Silty gray clay.
15-18	523.8	Soft	9	12	33.0	15-18: Uniform. Silty gray clay, some pockets and layers of sand.
16-18	518.8	Very Soft	7	12	29.3	16-18: Uniform. Silty gray clay, little sand.
17-18	513.8	Soft	8	12	34.7	17-18: Uniform. Silty gray clay, little sand.
18-18	508.8	Soft	9	12	26.0	18-18: Uniform. Silty gray clay, little sand.
19-18	503.8	Soft	8	12	27.4	19-18: Uniform. Silty gray clay, little sand.
20-18	498.8	Soft	5	12	28.0	20-18: Uniform. Silty gray clay, little sand, trace of fine gravel.
21-18	493.8	Soft	5	12	29.4	21-18: Uniform. Silty gray clay, little sand, trace of fine gravel.
22-18	487.3	—	8	12		22-18: Uniform. Silty gray clay, little sand, trace of fine gravel.
23-18	482.3	—	5	12		23-18: Uniform. Silty gray clay, little sand, trace of fine gravel.
24-18	478.8	Soft	2	12	24.6	24-18: Uniform. Silty gray clay, little sand, trace of fine gravel.
25-18	473.3	Soft	9	12	24.5	25-18: Uniform. Silty gray clay, little sand, trace of fine gravel.
26-18	468.3	—	6	12		26-18: Uniform. Silty gray clay, little sand, trace of fine gravel.
27-18	462.8	Very Soft	6	12	20.4	27-18: Uniform. Silty gray clay, little sand, trace of fine gravel.
28-18	457.8	Soft	9	12	22.8	28-18: Uniform. Silty gray clay, little sand, trace of fine gravel.
29-18	453.3	—	200	12		29-18: Uniform. Silty gray clay, little sand, trace of fine gravel.
30-18	449.3	—	350	12		30-18: Uniform. Silty gray clay, little sand, trace of fine gravel.
31-18	444.8	—	150	12		31-18: Uniform. Silty gray clay, little sand, trace of fine gravel.
REMARKS: Number of blows required to drive cone sampler distance given using a 140-pound weight falling 30 inches.						



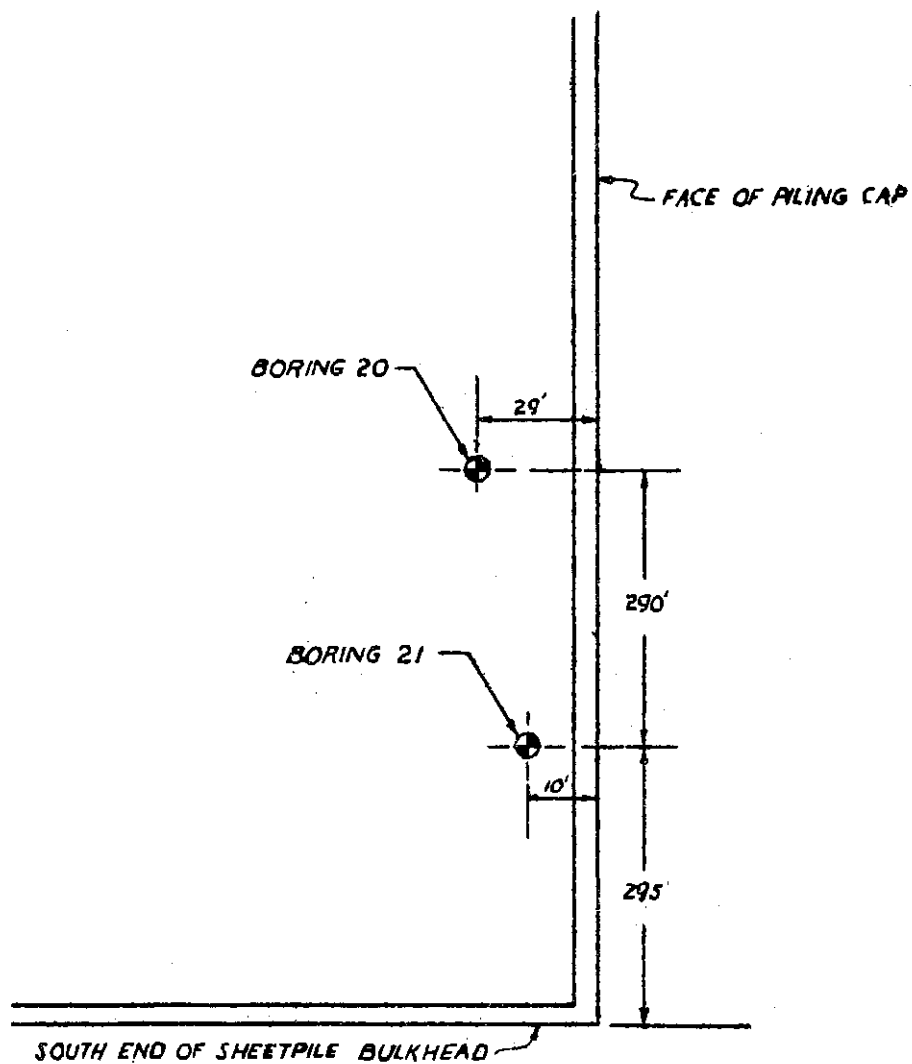
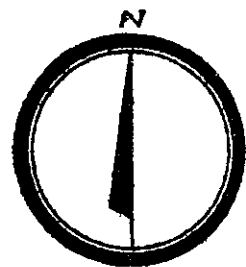
Boring Log and all sampling by Raymond Concrete Pile Division of Raymond International, Inc. Their Job No. CR-4043-D Date of Boring: 7-8-1966

Failure to recover 12-18 sample.

REMARKS: Number of blows required to drive cone sampler otherwise given using a 140-pound weight falling 30 inches.

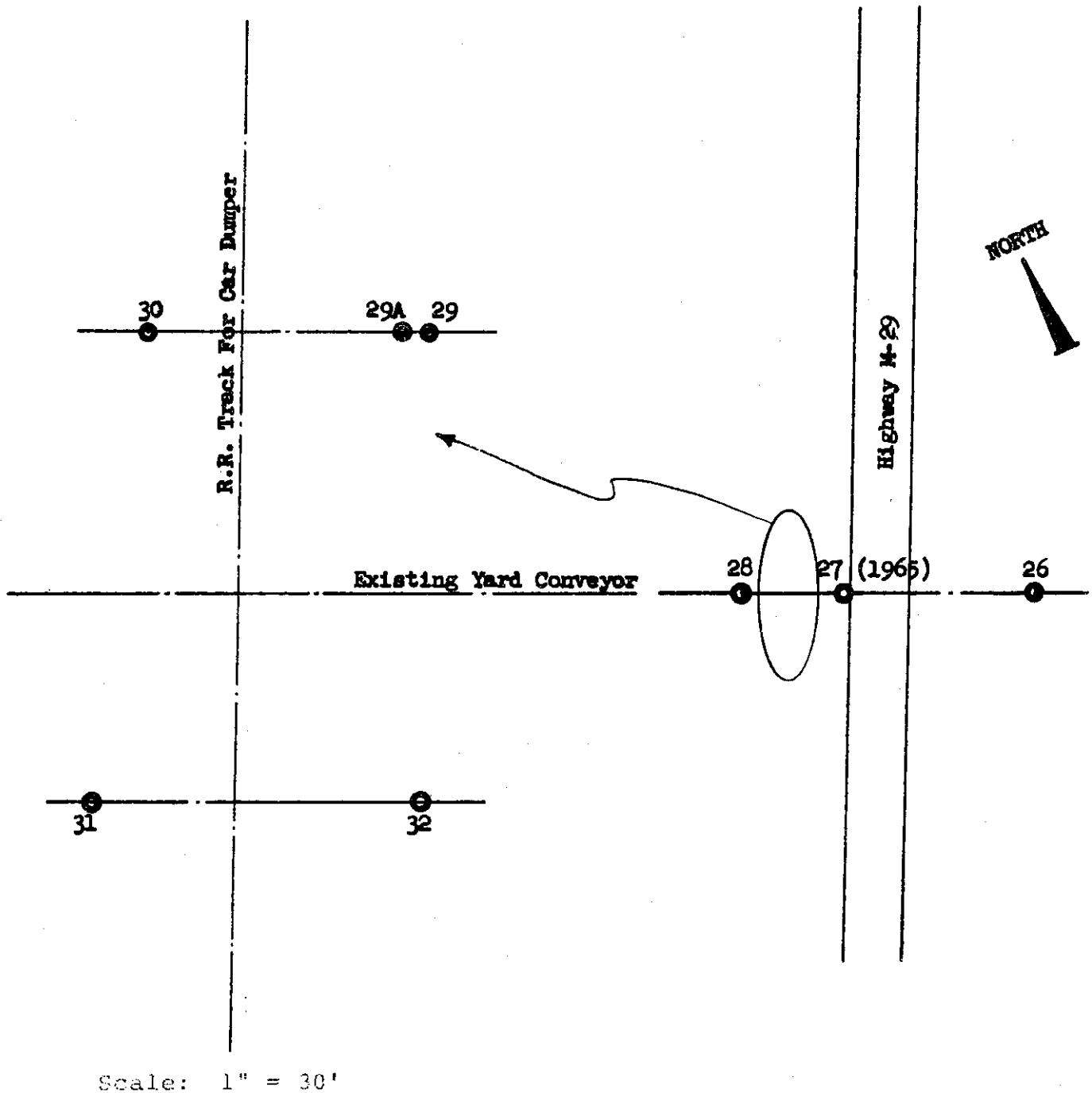
UNIVERSITY OF MICHIGAN RESEARCH INSTITUTE
SOIL MECHANICS LABORATORY
ANN ARBOR MICHIGAN
SUBSOIL ANALYSIS OF BORING NO. 27
ON CLARENCE POWER PLANT
THE DETROIT ENGINE COMPANY ST. CLAIR, MICHIGAN
APPROVED: *W. H. Howard* DATE: 4-5-1966
PROJECT: 01994

ADDITIONAL St. CLAIR PLANT INFORMATION



NOT TO SCALE

BORING LOCATION PLAN	
ST. CLAIR POWER PLANT	
DETROIT Edison COMPANY	
DETROIT	MICHIGAN
UNIV. OF MICHIGAN PROJECT 01994	

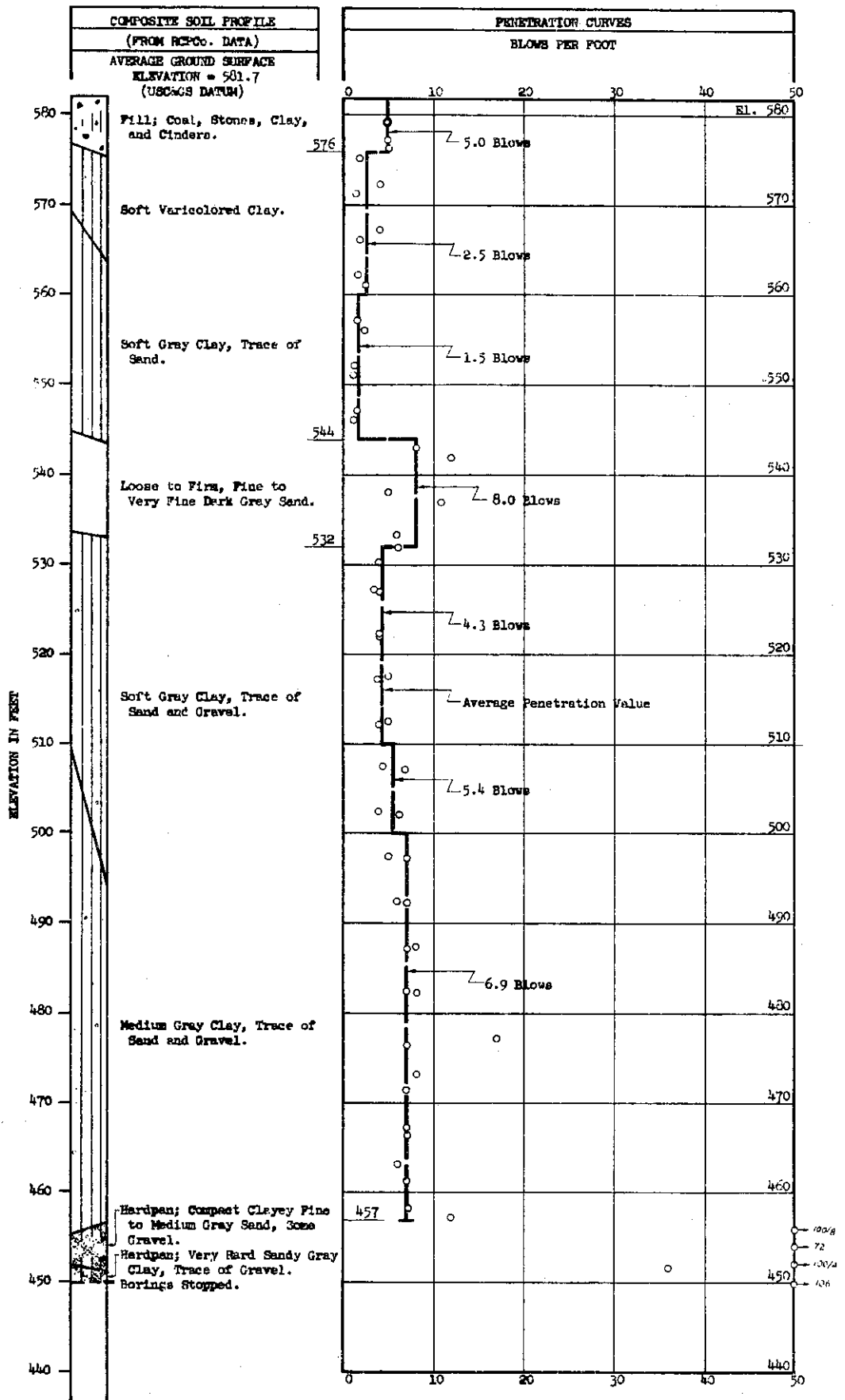


- 1965 and 1966 Borings with Liner Samples
- ⊙ 1965 Borings without Liner Samples

Scale: 1" = 300'

BORING LOCATION PLAN	
CAR DUMPER HOUSE	
ST. CLAIR POWER PLANT	
THE DETROIT EDISON CO.	
BELLE RIVER	MICHIGAN

CRA PROJECT NO. 01994



NOTE: The above Composite Soil Profile is intended only to present average conditions throughout the group of borings represented. See individual boring charts for details.

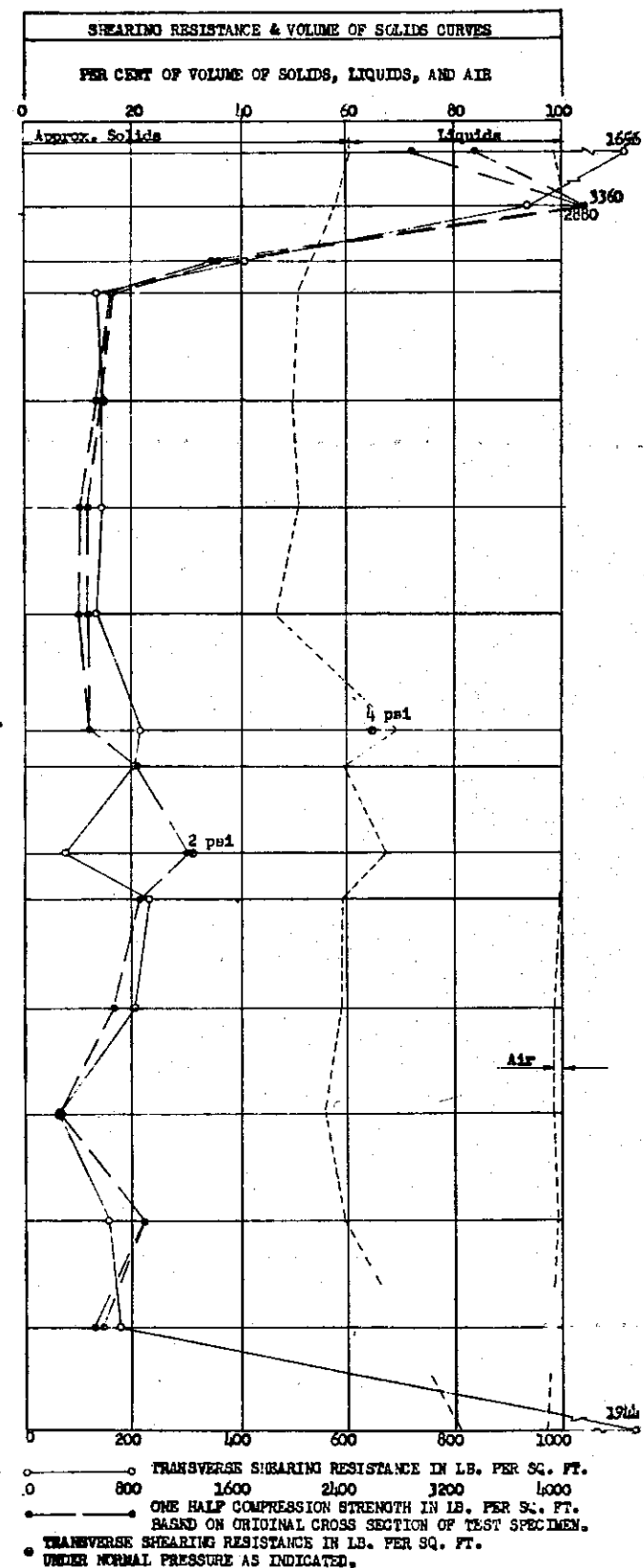
BLOWS PER FOOT USING A 140-POUND WEIGHT FALLING 30 INCHES

UNIVERSITY OF MICHIGAN RESEARCH INSTITUTE SOIL MECHANICS LABORATORY	
ANN ARBOR	MICHIGAN
PENETRATION VALUES OF BORINGS NO. 20 and 21 ST. CLAIR POWER PLANT - DETROIT EDISON COMPANY	
DETROIT	MICHIGAN
APPROVED: <i>[Signature]</i>	DATE: 2-5-52

Boring Logs

LOG OF SOIL PROFILE		SOIL SAMPLE						LABORATORY VISUAL INSPECTION	
BY BORING VISUAL INSPECTION		SA. NO.	ELEV. FT.	LAB. CONSID. TENCY	NO. OF BLOWS	DRIVE IN FEET	% H ₂ O	DRY WT. LB. PER CU. FT.	REMARKS
GROUND SURFACE ELEVATION = 588.7' (MC & GS DATUM)		1-LS	585.7	Hard	15	12	23.3	101.7	1-LS: Uniform, very fine texture. Smooth vari-colored clay, little silt, sl. tr. sand.
Med. V. Colored Clay.		2-LS	580.7	Stiff	24	12	27.4	97.3	2-LS: Uniform, very fine texture. Smooth vari-colored clay. Little silt.
Hard Vari-Colored Clay, Little Sand, Trace of Gravel.		3-LS	575.7	Stiff	7	12	36.9	86.1	3-LS: Uniform, very fine texture. Smooth vari-colored clay. Little silt.
Med. Vari-Colored Clay, Tr. Sand & Gravel.		4-LS	572.7	Soft	3	12	35.8	85.5	4-LS: Uniform, very fine texture. Smooth blue clay. Little silt.
		5-LS	562.7	Soft	3	12	38.4	83.6	5-LS: Uniform, very fine texture. V. smooth blue clay. Little silt.
Soft Blue Clay, Trace of Sand & Gravel.		6-LS	552.7	Soft	3	13	36.7	84.9	6-LS: Uniform, very fine texture. V. smooth blue clay. Little silt.
		7-LS	542.7	Soft	3	12	43.1	78.0	7-LS: Uniform, very fine texture. V. smooth silty blue clay.
		8-LS	531.7	W.C.	10	12	16.9	114.8	8-LS: Uniform, very fine to fine texture. V. f. to f. gray sand. Some sl., little silt.
Clayey, Med. Dark Sand, Little Gravel. Soft Blue Clay, Little Sand & Gravel, Seams of Sand.		9-LS	528.4	Soft	5	12	24.8	100.2	9-LS: Uniform, very fine texture. Smooth blue clay. Little silt, tr. sand.
		10-LS	520.2	W.C.	12	12	19.0	111.1	10-LS: Uniform, very fine texture. Dark gray clayey silt and very fine sand.
Clayey, V. Fine, Dark Sand, Little Gravel.		11-LS	515.9	Plastic	7	13	25.6	99.2	11-LS: Uniform, very fine texture. Silty blue clay. Trace sand.
		12-LS	505.7	Plastic	7	12	24.7	98.6	12-LS: Uniform, very fine texture. Smooth blue clay with little silt and sand.
Seam of Clayey, Fine Gray Sand.		13-LS	495.7	Soft	8	13	28.0	94.2	13-LS: Uniform, very fine texture. Blue clay with some silt & little sand.
Medium Blue Clay, Little Sand & Gravel, Few Sand Seams.		14-LS	485.7	Soft	8	12	25.2	99.2	14-LS: Uniform, very fine texture. Silty blue clay with little sand.
		15-LS	475.7	Soft	8	12	42.8	--	15-LS: Uniform, very fine texture. Silty blue clay.
Medium Blue Clay, Little Sand & Gravel. Sand Inclusions.		16-LS	465.2	Hard	222	12	7.3	136.0	16-LS: Uniform, very fine texture. Sandy, silty gray clay with pebbles.
Hardpan; Compact Clayey Fine Gray Sand, Seams of Clean Sand & Gr., Few Boulders.			461.4	--	200	6			PENETRATION NOTE: Number of blows required to drive core sampler distance given using 110-pound weight falling 30 inches.
Boring Stopped.			455.5	--	200	4			

Boring Log and all sampling by Raymond Concrete Pile Company. Their Job No. D-7153-D.



ENGINEERING RESEARCH INSTITUTE
SOIL MECHANICS LABORATORY
UNIVERSITY OF MICHIGAN, ANN ARBOR, MICHIGAN

SUBSOIL ANALYSIS OF BORING NO. 3
ST. CLAIR RIVER SITE, MARINE CITY, MICHIGAN
THE DETROIT EDISON COMPANY

APPROVED: *J. H. Howell* DATE: 2-13-50
UNIVERSITY OF MICHIGAN PROJECT M373-66

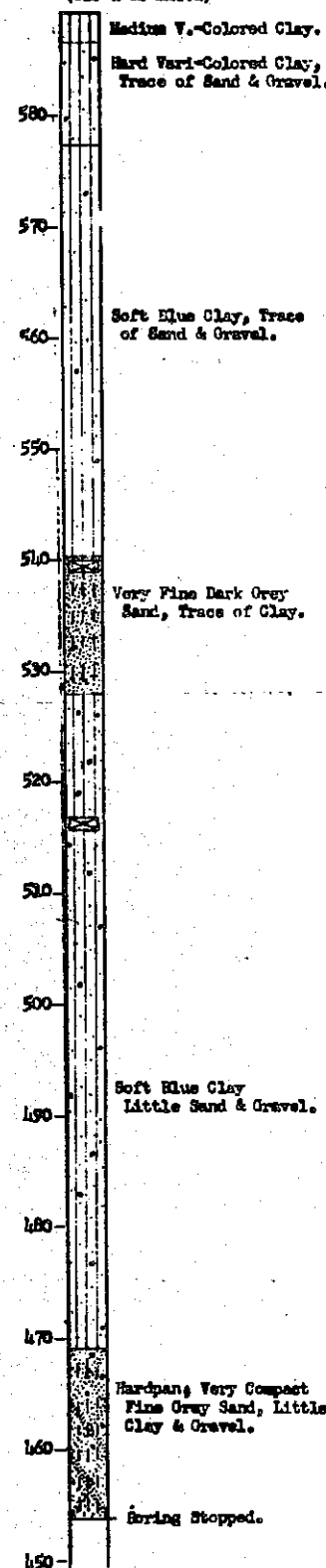
LOG OF SOIL PROFILE

BY BORING VISUAL INSPECTION

GROUND SURFACE

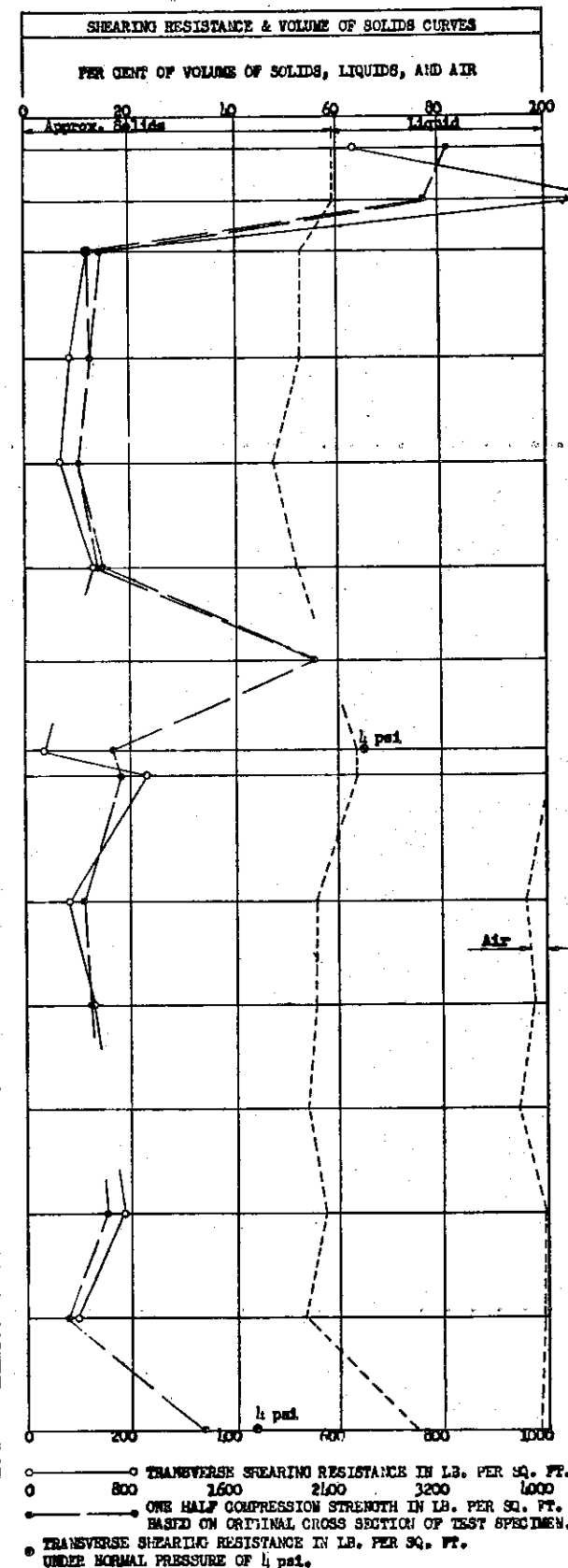
ELEVATION = 589.3'

(USC & OS DATUM)



SOIL SAMPLE		LABORATORY VISUAL INSPECTION	
SA. NO.	ELEV.	LAB. CONSIS. NO. OF TENS. BLOWS	REMARKS
1-LS	586.3	V.Stiff 11	1-LS: Uniform, very fine texture. Silty vari-colored clay with trace organics.
2-LS	581.3	Hard 22	2-LS: Uniform, very fine texture. Silty vari-colored clay. Trace pebbles.
3-LS	576.5	Soft 4	3-LS: Uniform, very fine texture. Silty blue clay. Sl. trace sand.
4-LS	566.3	Soft 3	4-LS: Uniform, very fine texture. Smooth blue clay with little silt.
5-LS	556.3	V.Soft 2	5-LS: Uniform, very fine texture. Smooth blue clay with little silt.
6-LS	546.3	Soft 2	6-LS: Uniform, very fine texture. Smooth blue clay with little silt.
7-LS	539.5	Weakly Cohesive 12	7-LS: Uniform, very fine texture. Gray very fine to fine sand with little silt.
8-LS	528.7	Weakly Cohesive 7	8-LS: Uniform, very fine texture. Gray very fine sand with some clay & silt.
9-LS	526.1	Soft 6	9-LS: Uniform, very fine texture. Blue clay with little silt and sand. Trace pebbles.
10-LS	516.3	V.Soft 7	10-LS: Uniform, very fine texture. Smooth silty blue clay with little sand.
11-LS	504.3	Soft 8	11-LS: Uniform, very fine texture. Smooth silty blue clay.
12-LS	494.3	V.Soft 9	12-LS: Uniform, very fine texture. Smooth silty blue clay.
13-LS	484.3	Soft 9	13-LS: Uniform, very fine texture. Smooth silty blue clay.
14-LS	474.3	V.Soft 9	14-LS: Uniform, very fine texture. Smooth silty blue clay.
15-LS	463.5	Weakly Cohesive 71	15-LS: Uniform, v.fine to fine texture. Clayey v.fine to fine gray sand.
16-BS	459.1	Compact 225	16-BS: Uniform, v.fine to fine texture. Clayey v.fine to fine gray sand.
17-LS	454.3	200	Indicates failure to recover liner sample.

Indicates failure to recover liner sample.
PENETRATION NOTE: Number of blows required to drive core sampler distance given using 140-pound weight falling 30 inches.



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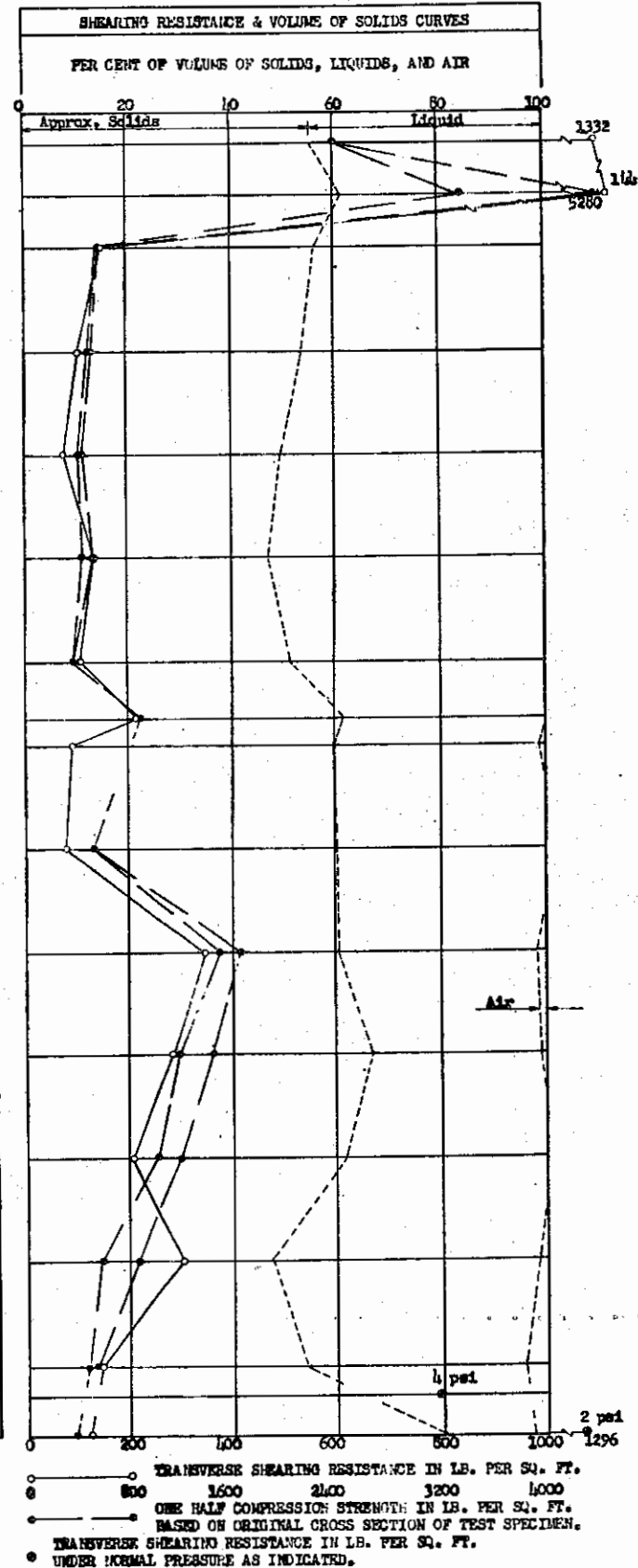
SUBSOIL ANALYSIS OF BORING NO. 1
ST. CLAIR RIVER SITE, WARREN CITY, MICHIGAN
THE DETROIT EDISON COMPANY

APPROVED: *W. H. Hall* DATE: 12-13-50
UNIVERSITY OF MICHIGAN PROJECT M373-66

Boring log and all sampling
by Raymond Concrete Pile Company.
Their Job No. 9-7153-0.

LOG OF SOIL PROFILE		SOIL SAMPLE						LABORATORY VISUAL INSPECTION	
BY RCPD VISUAL INSPECTION		SA. NO.	ELEV.	LAB. CONCISE	NO. OF BLOWS	DRIVE IN INCHES	% H ₂ O BY DRY WT.	DRY WT. LB. PER CU. FT.	REMARKS
GROUND SURFACE ELEVATION = 539.3' (USC & GS DATUM)									
Topsoil. Med. Vari-Colored Clay.		1-LS	586.3	V. Stiff	15	12	29.7	93.6	1-LS: Uniform, very fine texture. Vari-colored with little silt.
Hard Vari-Colored, Trace of Sand & Gravel.		2-LS	581.3	V. Stiff	14	12	25.2	103.0	2-LS: Uniform, very fine texture. Silty vari-colored clay.
		3-LS	576.3	Soft	4	13	29.7	94.2	3-LS: Uniform, very fine texture. Silty blue clay.
		4-LS	566.3	Soft	3	12	33.3	90.5	4-LS: Uniform, very fine texture. Silty blue clay.
Soft Blue Clay, Trace of Sand & Gravel.		5-LS	556.3	Soft	3	13	38.5	83.0	5-LS: Uniform, very fine texture. Silty blue clay.
		6-LS	546.3	Soft	3	13	41.3	79.2	6-LS: Uniform, very fine texture. Silty blue clay.
		7-LS	536.3	Soft	4	14	34.9	86.1	7-LS: Uniform, very fine texture. Silty blue clay. Trace sand and pebbles.
Med. to Coarse Sand & Gravel, Little Clay.		8-LS	530.8	Plastic	22	12	23.8	101.0	8-LS: Uniform, very fine texture. Blue clay with little silt. Tr. sand & pebbles.
		9-LS	528.3	V. Soft	6	12	23.8	100.5	9-LS: Uniform, very fine texture. Blue clay with little silt. Tr. pebbles.
Soft Blue Clay, Little Sand & Gravel.		10-LS	518.3	Soft	7	12	26.0	101.1	10-LS: Uniform, very fine texture. Sandy blue clay with some silt. Tr. pebbles.
		11-LS	508.3	Plastic to Firm	9	12	23.4	101.1	11-LS: Uniform, very fine texture. Blue clay with some silt. Tr. pebbles.
Medium Blue Clay, Little Sand & Gravel.		12-LS	498.3	Plastic	9	12	17.7	112.1	12-LS: Uniform, very fine texture. Silty blue clay.
		13-LS	488.3	Plastic	11	12	23.8	101.6	13-LS: Uniform, very fine texture. Silty blue clay with pebbles.
Soft Blue Clay, Trace of Sand & Gravel.		14-LS	478.3	Plastic	8	12	40.1	72.9	14-LS: Uniform, very fine texture. Silty blue clay. Tr. sand. Internal voids.
		15-LS	468.3	Plastic	8	12	39.5	78.0	15-LS: Uniform, very fine texture. Silty blue clay. Internal voids.
Hardpan; Compact Fine to Medium Gray Sand, Little Gravel and Clay, Scams of Clayey Sand. Few Boulders.		16-LS	465.4	Non-C.	159	12	--	--	16-LS: Non-uniform. Varies from blue clay to medium gray sand.
		17-LS	461.0	W.C.	200	8	7.9	136.0	17-LS: Uniform, coarse texture. Clayey silt and sand with little gravel.

Penetration Note: Number of blows required to drive core sampler distance given using 140-pound weight falling 30 inches.

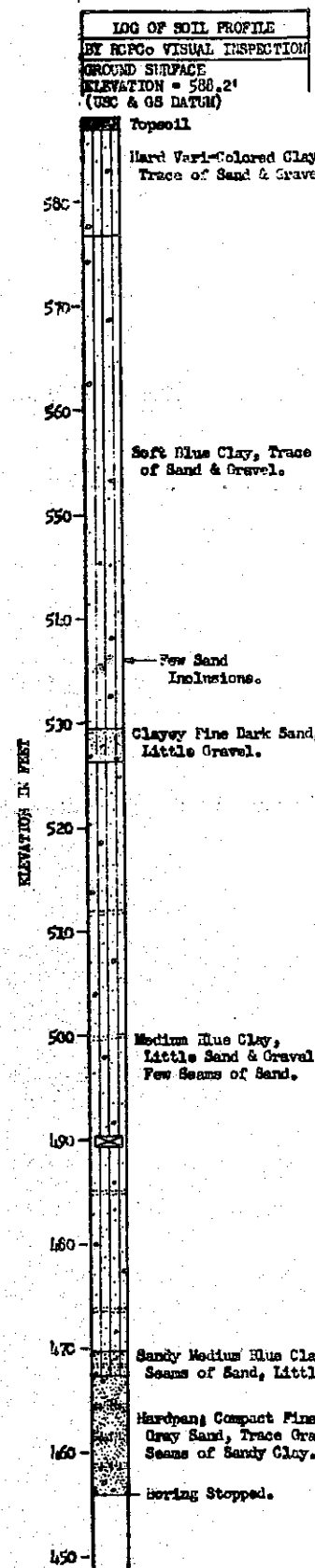


Boring Log and all sampling
by Raymond Concrete Pile Company.
Their Job No. 9-753-D.

ENGINEERING RESEARCH INSTITUTE
SOIL MECHANICS LABORATORY
UNIVERSITY OF MICHIGAN, ANN ARBOR, MICHIGAN

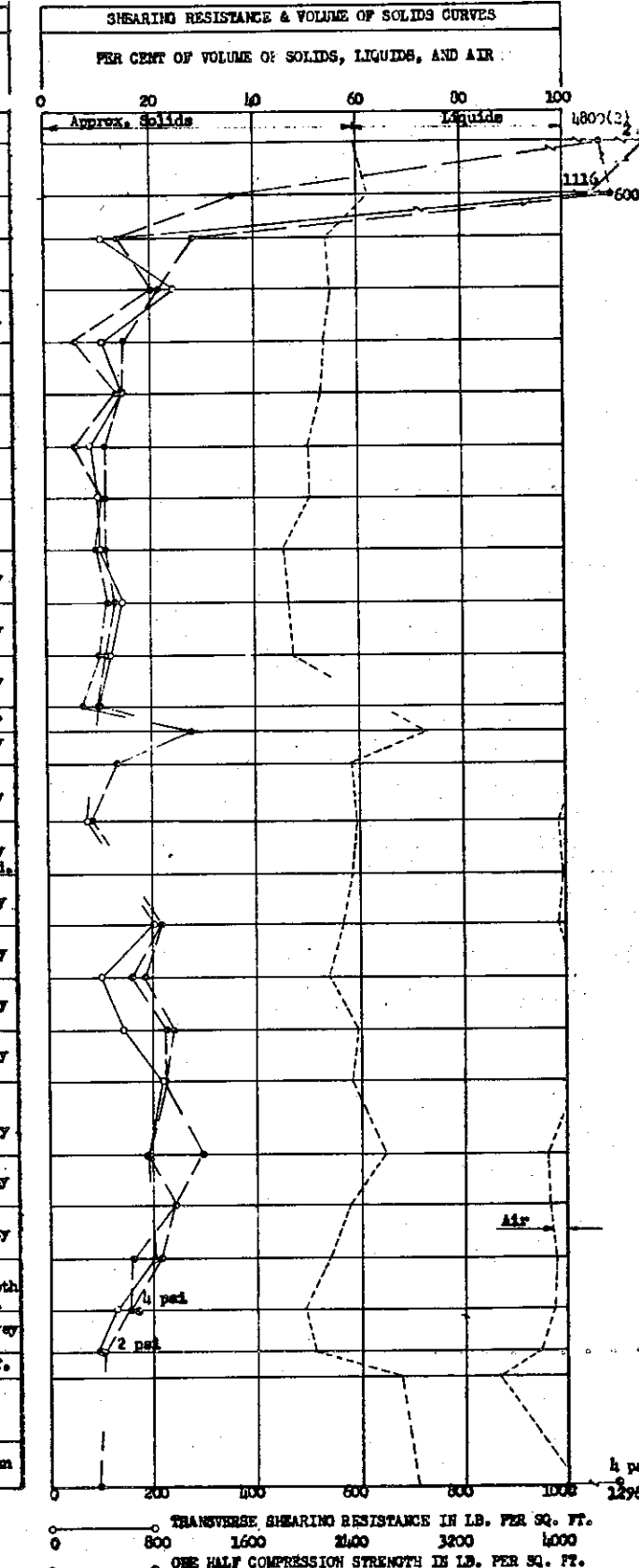
SUBSOIL ANALYSIS OF BORING NO. 2
ST. CLAIR RIVER SITE, MARINE CITY, MICHIGAN
THE DETROIT EDISON COMPANY

APPROVED: *W. H. Housel* DATE: 12-15-50
UNIVERSITY OF MICHIGAN PROJECT 1073-66



SOIL SAMPLE										LABORATORY VISUAL INSPECTION	
SA. NO.	ELEV. FEET	LAB. TEST	NO. OF BLOWS	DRY WT. LB.	WATER CONTENT, %	DRY WT. LB.	WATER CONTENT, %	DRY WT. LB.	WATER CONTENT, %	REMARKS	
1-LS	585.2	Hard	18	12	24.8	99.8				1-LS: Uniform, fine texture. Vari-colored clay with little silt.	
2-LS	580.2	V. Stiff	20	12	23.0	101.2				2-LS: Uniform, very fine texture. Silty vari-colored clay. Trace pebbles.	
3-LS	576.2	Plastic	1	13	32.1	90.5				3-LS: Uniform, very fine texture. Silty blue clay.	
4-LS	571.2	Plastic	3	12	30.6	91.7				4-LS: Uniform, very fine texture. Silty blue clay. Trace of pebbles.	
5-LS	566.2	Soft	1	14	32.9	89.2				5-LS: Uniform, very fine texture. Smooth silty blue clay.	
6-LS	561.2	Soft	1	13	33.8	88.6				6-LS: Uniform, very fine texture. Blue clay with little silt.	
7-LS	556.2	Soft	3	12	38.4	84.2				7-LS: Uniform, very fine texture. Silty blue clay.	
8-LS	551.2	Soft	3	14	36.4	85.5				8-LS: Uniform, very fine texture. Silty blue clay.	
9-LS	546.2	Soft	3	14	45.3	76.1				9-LS: Uniform, very fine texture. Silty blue clay with little sand.	
10-LS	541.2	Soft	3	14	43.3	77.4				10-LS: Uniform, very fine texture. Silty blue clay.	
11-LS	536.2	Soft	3	12	42.3	79.2				11-LS: Uniform, very fine texture. Silty blue clay.	
12-LS	531.2	Soft	3	13	43.4	-				12-LS: Uniform, very fine texture. Silty blue clay.	
13-LS	528.9	W.C.	10	12	44.2	119.8				13-LS: Uniform, fine texture. F. to med. gray clayey sand, tr. of gravel.	
14-LS	525.7	V. Soft	6	12	28.1	98.0				14-LS: Uniform, very fine texture. Silty blue clay. Trace pebbles.	
15-LS	520.2	V. Soft	7	12	24.6	99.8				15-LS: Uniform, very fine texture. Silty blue clay with tr. of gravel.	
16-LS	515.2	V. Soft	8	13	26.4	98.0				16-LS: Uniform, very fine texture. Silty blue clay, little sand. Tr. of gravel.	
17-LS	510.2	V. Soft	7	12	27.1	95.5				17-LS: Uniform, very fine texture. Silty blue clay. Trace pebbles.	
18-LS	505.2	V. Soft	7	12	32.7	90.5				18-LS: Uniform, very fine texture. Silty blue clay.	
19-LS	500.2	Plastic	8	13	27.8	94.8				19-LS: Uniform, very fine texture. Silty blue clay. Some sand. Trace pebbles.	
20-LS	495.2	Plastic	8	12	28.2	97.3				20-LS: Uniform, very fine texture. Silty blue clay. Some sand. Trace pebbles.	
21-LS	490.2	-	9	12						21-LS: Uniform, very fine texture. Silty blue clay. Some sand. Trace pebbles.	
22-LS	488.2	Plastic	9	12	18.3	108.6				22-LS: Uniform, very fine texture. Silty blue clay. Little sand. Trace pebbles.	
23-LS	483.2	Soft	10	12	25.1	96.7				23-LS: Uniform, very fine texture. Silty blue clay with little sand.	
24-LS	478.2	Plastic	9	12	30.1	90.5				24-LS: Uniform, very fine texture. Smooth blue clay with little silt. Int. voids.	
25-LS	473.2	Soft	8	12	36.8	82.4				25-LS: Uniform, very fine texture. Clayey gray silt with little sand.	
26-LS	469.2	Soft	10	12	31.4	86.1				26-LS: Uniform, fine texture. Clean v.f. to f. gray sand. Seams silty clay.	
27-LS	466.7	W.C.	60	12	10.3	114.2				27-LS: Uniform, fine texture. Silty very fine to fine gray sand.	
28-LS	460.8	Compact	200	5						28-LS: Uniform, very fine texture. Clean v.f. to f. gray sand and silt. Seams of clay.	
29-LS	455.8	Hard	320	10	16.5	117.3					

Indicates failure to recover liner sample.
PENETRATION NOTE: Number of blows required to drive core sampler distance given using 140-pound weight falling 30 inches.



Boring Log and all sampling
by Raymond Concrete Pile Company.
Their Job No. B-7453-D.

ENGINEERING RESEARCH INSTITUTE
SOIL MECHANICS LABORATORY
UNIVERSITY OF MICHIGAN, ANN ARBOR, MICHIGAN
SUBSOIL ANALYSIS OF BORING NO. 1
ST. CLAIR RIVER SITE, MARINE CITY, MICHIGAN
THE DETROIT EDISON COMPANY
APPROVED: *W.D. Housel* DATE: 12-13-50
UNIVERSITY OF MICHIGAN PROJECT MGT-66

LOG OF SOIL PROFILE

BY RCPG VISUAL INSPECTION

GROUND SURFACE ELEVATION = 588.4 (USC & GS DATUM)

Topsoil.

Hard Vari-Colored Clay,
Trace of Sand & Gravel.

Soft Blue Clay,
Trace of Sand &
Gravel.

Sand Inclusions.

Medium Blue Clay,
Little Sand & Gravel,
Few Sand Seams.

Med. Hard Blue Clay,
Some Sand Inclusions,
Little Gravel.

Soft Blue Clay,
Trace of Sand, Gravel
& Sand Inclusions.

Hardpan, Fine to Med.
Gray Sand.

Hardpan, Some Clay,
Trace of Gravel,
Scars of Sand and
Hard Sandy Clay.

Boring Stopped.

SOIL SAMPLE

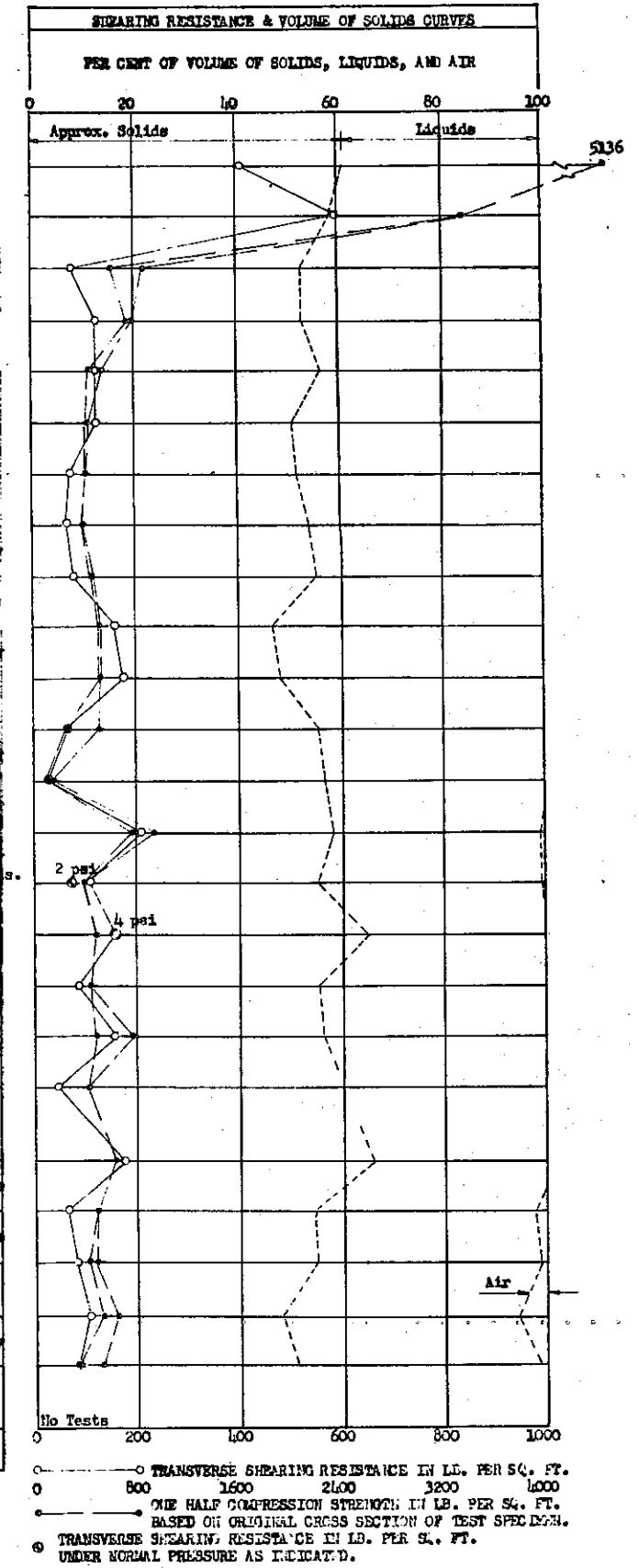
LABORATORY VISUAL INSPECTION

REMARKS

SA. NO.	ELEV. TRCT	LAB. NO.	PENETRATION DRIVE BY FT.	% H ₂ O	DET. LB. PER	REMARKS
1-B	584.5	- -	10	12		2-LS: Uniform, very fine texture. Vari-colored clay with little silt.
2-LS	583.0	Plastic	21	12	24.9	3-LS: Uniform, very fine texture. Silty vari-colored clay with tr. pebbles.
3-LS	578.0	Plastic	15	12	26.8	4-LS: Uniform, very fine texture. Silty blue clay.
4-LS	573.0	Soft	6	12	33.7	5-LS: Uniform, very fine texture. Silty blue clay.
5-LS	568.0	Soft	4	14	33.0	6-LS: Uniform, very fine texture. Silty blue clay with pebbles.
6-LS	563.0	Soft	3	12	28.9	7-LS: Uniform, very fine texture. Silty blue clay.
7-LS	558.0	Soft	3	12	35.3	8-LS: Uniform, very fine texture. Smooth silty blue clay with pebbles.
8-LS	553.0	Soft	3	12	35.2	9-LS: Uniform, very fine texture. Silty blue clay.
9-LS	548.0	Soft	3	12	32.5	10-LS: Uniform, very fine texture. Silty blue clay.
10-LS	543.0	Soft	3	12	31.8	11-LS: Uniform, very fine texture. Silty blue clay with little sand.
11-LS	538.0	Plastic	4	13	44.2	12-LS: Uniform, very fine texture. Silty blue clay with little sand.
12-LS	533.0	Plastic	4	12	39.6	13-LS: Uniform, very fine texture. Blue clay with little silt. Tr. sand & pebs.
13-LS	528.0	Soft	5	12	29.5	14-LS: Uniform, very fine texture. Silty blue clay with little sand. Tr. pebbles.
14-LS	523.0	Soft	6	12	28.5	15-LS: Uniform, very fine texture. Silty blue clay with little sand. Tr. pebbles.
15-LS	518.0	Plastic	7	12	25.5	16-LS: Uniform, very fine texture. Silty blue clay. Little sand. Tr. pebs. Int. voids.
16-LS	513.0	Plastic	7	12	29.5	17-LS: Uniform, fine texture. Silty sandy blue clay with pebbles.
17-LS	508.0	Soft	7	12	20.3	18-LS: Uniform, fine texture. Silty sandy blue clay with pebs. Int. voids.
18-LS	503.0	Soft	7	12	29.3	19-LS: Uniform, fine texture. Silty sandy blue clay with pebs. Int. voids.
19-LS	498.0	Soft	7	12	29.0	20-LS: Uniform, fine texture. Silty sandy blue clay with pebbles.
20-LS	493.0	Soft	8	13	23.6	21-LS: Uniform, fine texture. Blue clay. Some silt. Little sand. Tr. pebs.
21-LS	488.0	Plastic	12	12	19.2	22-LS: Uniform, fine texture. Silty blue clay. Some sand. Tr. pebbles. Int. voids.
22-LS	483.0	Soft	7	12	29.1	23-LS: Uniform, fine texture. Silty blue clay. Some sand. Tr. pebbles. Int. voids.
23-LS	478.0	Plastic	8	12	29.6	24-LS: Uniform, fine texture. Silty blue clay with little sand. Int. voids.
24-LS	473.0	Plastic	6	12	35.1	25-LS: Uniform, very fine texture. Silty blue clay with internal voids.
25-LS	468.0	Soft	8	12	34.2	26-LS: Uniform, very fine texture. Fine to med. gray sand. Some clay. Tr. pebs.
26-LS	463.0	Weakly coherent	15	12	13.2	
27-LS	458.0	- -	225	5		
28-LS	453.0	- -	200	3		

Indicates failure to recover liner sample.

PENETRATION NOTE: Number of blows required to drive core sampler distance given using 140-pound weight falling 30 inches.

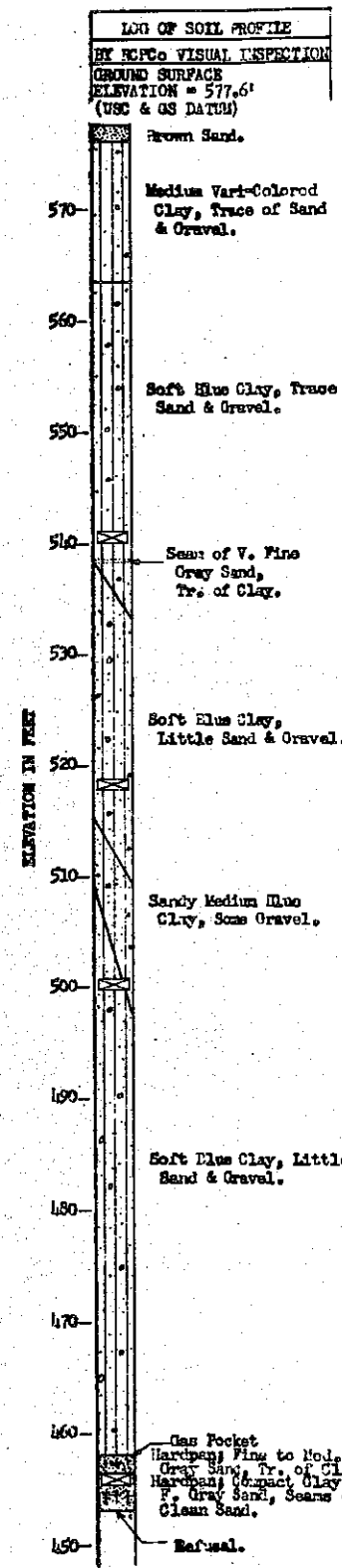


ENGINEERING RESEARCH INSTITUTE
SOIL MECHANICS LABORATORY
UNIVERSITY OF MICHIGAN, ANN ARBOR, MICHIGAN

SUBSOIL ANALYSIS OF BORING NO. 5
ST. CLAIR RIVER SITE, MARINE CITY, MICHIGAN
THE PETROBRAS COMPANY

APPROVED: *[Signature]* DATE: 2-3-54
UNIVERSITY OF MICHIGAN REPORT 1073-54 A-21

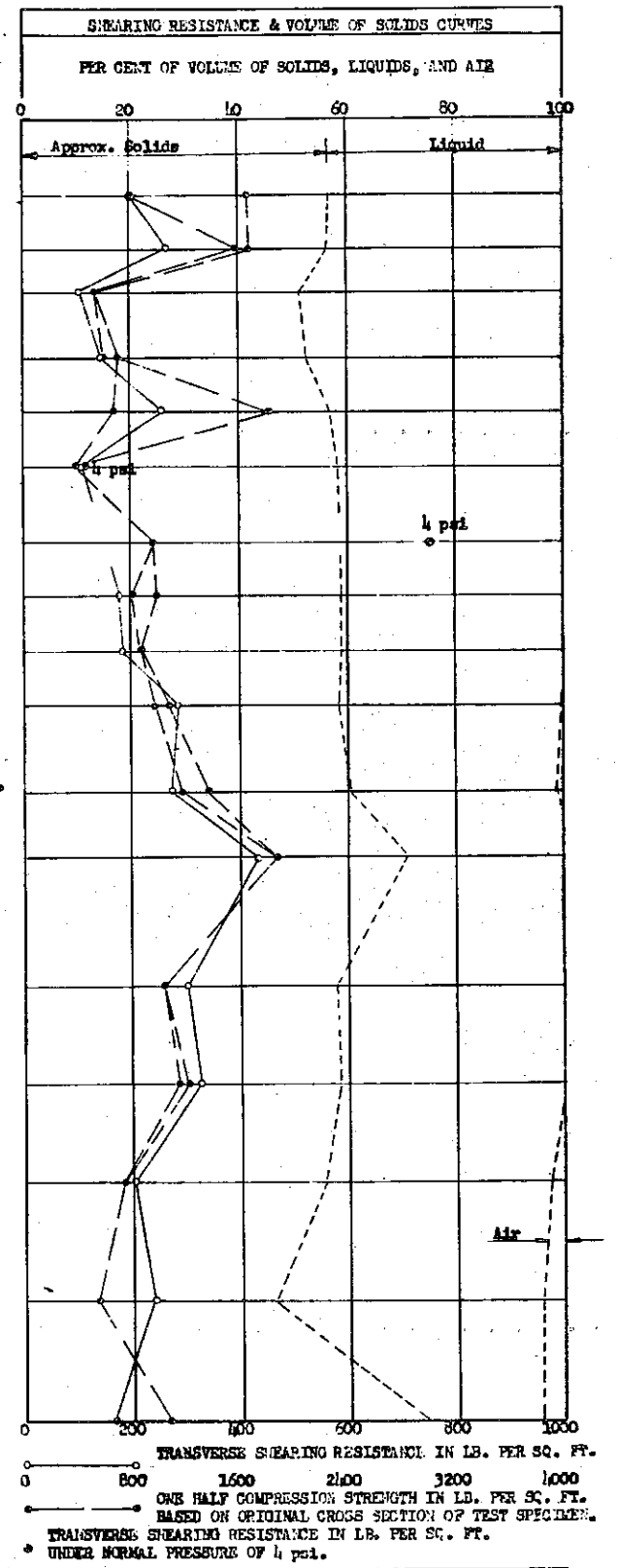
Boring Log and all sampling
by Diamond Concrete Pile Company.
Chief Job No. 5-100-1.



SA. NO.	LAB. NO.	PENETRATION	MO. OF	BY	WT. LB.	DRY	REMARKS
1-LS	574.2	-	6	12			2-LS: Uniform, very fine texture. Silty vari-colored clay.
2-LS	570.6	Plastic	6	12	29.8	95.5	3-LS: Uniform, very fine texture. Silty vari-colored clay.
3-LS	565.3	Plastic	6	12	31.9	94.2	4-LS: Uniform, very fine texture. Smooth silty blue clay.
4-LS	561.6	Soft	5	12	37.5	86.1	5-LS: Uniform, very fine texture. Smooth silty blue clay.
5-LS	555.6	Soft	3	12	34.4	88.0	6-LS: Uniform, very fine texture. Smooth silty blue clay.
6-LS	550.6	Plastic	3	12	29.4	95.5	7-LS: Uniform, fine texture. Blue clay with some silt. Little sand.
7-LS	546.6	Weakly Coherent	2	14	27.3	97.3	8-LS: Non-uniform, fine texture. Varies from gray silt to silty gray clay.
8-LS	540.6	Non-Plastic	3	12			9-LS: Uniform, very fine texture. Silty blue clay with pebbles.
9-LS	538.6	Plastic	4	13	20.9	107.3	10-LS: Uniform, very fine texture. Silty blue clay with pebbles.
10-LS	533.6	Plastic	3	13	25.4	99.2	11-LS: Uniform, very fine texture. Silty blue clay with little sand. Tr. pebbles.
11-LS	528.6	Plastic	2	12	26.1	99.2	12-LS: Uniform, very fine texture. Silty blue clay. Little sand. Tr. pebbles. Int. voids.
12-LS	523.6	Plastic	3	13	26.2	98.0	13-LS: Uniform, very fine texture. Silty blue clay. Little sand.
13-LS	518.6	-	4	13			14-LS: Uniform, very fine texture. Smooth silty blue clay with some silt & sand.
14-LS	515.6	Plastic	4	14	23.6	101.1	15-LS: Uniform, very fine texture. Smooth blue clay. Some silt. Tr. sand & pebs.
15-LS	509.6	Plastic	7	12	16.7	119.2	16-LS: Uniform, very fine texture. Smooth silty blue clay.
16-LS	500.6	-	6	12			17-LS: Uniform, very fine texture. Smooth blue clay. Little silt.
17-LS	497.6	Plastic	6	12	26.8	97.3	18-LS: Uniform, very fine texture. Smooth blue clay. Little silt.
18-LS	488.6	Plastic	6	13	26.4	98.6	
19-LS	479.6	Plastic	6	12	27.9	91.6	
20-LS	468.6	Soft to Plastic	4	12	39.6	77.4	
21-LS	457.5	F. Stiff	28	12	10.7	124.8	
22-LS	456.3	-	160	8	-	-	

Indicates failure to recover Liner Sample.

PENETRATION NOTE: Number of blows required to drive core sampler distance given using 140-pound weight falling 31 inches.



Boring Log and all sampling
by Raymond Concrete Pile Company.
Their Job No. B-7453-D.

ENGINEERING RESEARCH INSTITUTE
SOIL MECHANICS LABORATORY
UNIVERSITY OF MICHIGAN, ANN ARBOR, MICHIGAN

SUBSOIL ANALYSIS OF BORING NO. 9
ST. CLAIR RIVER SITE, MARINE CITY, MICHIGAN
THE DETROIT EDISON COMPANY

APPROVED: *W. H. G. H. G.* DATE: 12-12-50

UNIVERSITY OF MICHIGAN PROJECT 1373-66

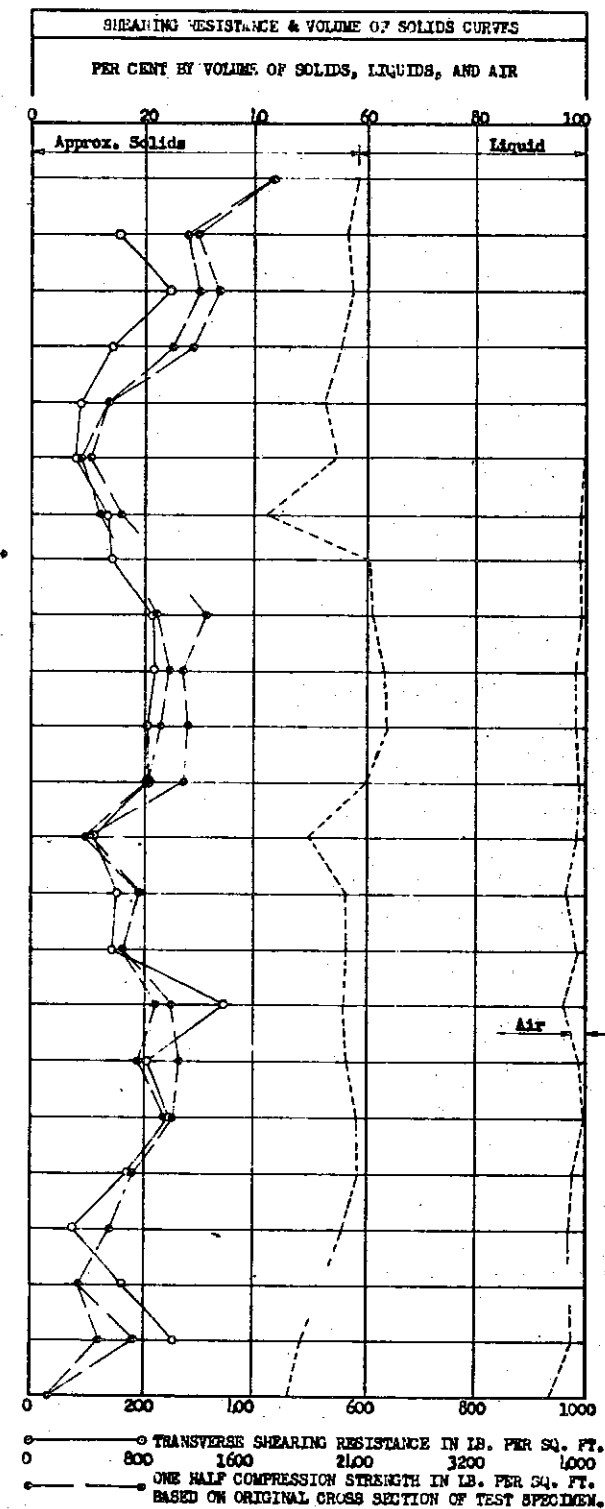
LOG OF SOIL PROFILE				SOIL SAMPLE						LABORATORY VISUAL INSPECTION	
BY MFCO VISUAL INSPECTION				SA.	LAD.	PENETRATION	% H ₂ O	DRY	REMARKS		
GROUND SURFACE				NO.	CONTS.	NO. OF	BY	WT. LB.			
ELEVATION - 577.2'					TEST	DRIVE		PER			
(USC & GS DATUM)					FLOWS	INCHES		CU. FT.			
ELEVATION IN FEET	570	Yellow Sand.	1-BS	573.7	--	6	12			2-LS: Uniform, very fine texture. Silty yellow clay.	
		Medium Yellow Clay, Trace of Sand & Gravel.	2-LS	572.2	Plastic Soft to	7	12	26.9	98.6	3-LS: Uniform, very fine texture. Silty blue clay.	
			3-LS	567.2	Plastic	3	12	29.6	94.8	4-LS: Uniform, very fine texture. Silty blue clay.	
			4-LS	562.2	Plastic Soft to	5	12	28.4	96.1	5-LS: Uniform, very fine texture. Silty blue clay.	
	560		5-LS	557.2	Plastic	4	12	30.1	93.0	6-LS: Uniform, very fine texture. Smooth silty blue clay.	
		Soft Blue Clay, Trace of Sand & Gravel.	6-LS	552.2	Soft	3	14	35.2	87.7	7-LS: Uniform, very fine texture. Smooth silty blue clay.	
	550		7-LS	547.2	V. Soft	3	14	31.3	91.1	8-LS: Uniform, very fine texture. Blue clay with little silt and sand.	
			8-LS	542.2	Soft	2	12	50.0	70.5	9-LS: Uniform, very fine texture. Blue clay with little silt. Tr. pebbles.	
	540		9-LS	538.2	Soft to	6	12	23.6	101.1	10-LS: Uniform, very fine texture. Blue clay with little silt and sand. Tr. pebbles.	
			10-LS	533.2	Plastic	5	13	23.2	102.3	11-LS: Uniform, fine texture. Silty blue clay with little sand and pebbles.	
	530		11-LS	528.2	Plastic	7	12	20.4	106.1	12-LS: Uniform, fine texture. Blue clay with some silt, little sd. & pebbles.	
			12-LS	523.2	Plastic	6	12	20.4	106.1	13-LS: Uniform, very fine texture. Silty blue clay with little sand.	
	520		13-LS	518.2	Plastic	6	12	24.2	100.5	14-LS: Uniform, very fine texture. V. smooth silty blue clay.	
		Soft Blue Clay, Little Sand & Gravel, Few Sand Seams.	14-LS	513.2	Soft	5	12	37.4	82.4	15-LS: Uniform, very fine texture. Smooth silty blue clay.	
	510		15-LS	508.2	Soft	5	12	26.8	94.2	16-LS: Uniform, very fine texture. Silty blue clay with little sand.	
			16-LS	503.2	Soft	5	12	27.3	94.8	17-LS: Uniform, very fine texture. Smooth blue clay with some silt.	
	500		17-LS	498.2	Plastic	5	12	26.6	93.6	18-LS: Uniform, very fine texture. Smooth silty blue clay with little sand.	
			18-LS	493.2	Plastic	6	12	27.2	95.5	19-LS: Uniform, very fine texture. Smooth silty blue clay. Little sand. Tr. pebbles.	
	490		19-LS	488.2	Plastic Soft to	6	12	26.5	98.0	20-LS: Uniform, very fine texture. Smooth silty blue clay.	
			20-LS	483.2	Plastic	7	12	24.4	98.6	21-LS: Uniform, very fine texture. Smooth blue clay with little silt. Tr. pebbles.	
	480		21-LS	478.2	Soft	7	12	27.2	93.6	22-LS: Uniform, very fine texture. Smooth blue clay with little silt. Tr. pebbles.	
		Medium Blue Clay, Little Sand & Gravel, Few Sand Seams.	22-LS	473.2	Soft	8	12	43.7	73.7	23-LS: Uniform, very fine texture. Smooth blue clay with little silt. Tr. pebbles.	
	470		23-LS	468.2	Plastic	7	12	36.3	81.7	24-LS: Uniform, very fine texture. Silty blue clay with some sand. Tr. pebbles.	
			24-LS	463.2	V. Soft	7	12	37.7	77.4		
	460		25-BS	455.7	--	130	9				
					56	1					

Comp. Clayey V. Gray Sand, Some Gr. Seams
Foreman Reports Sdy. Hard
Natural.

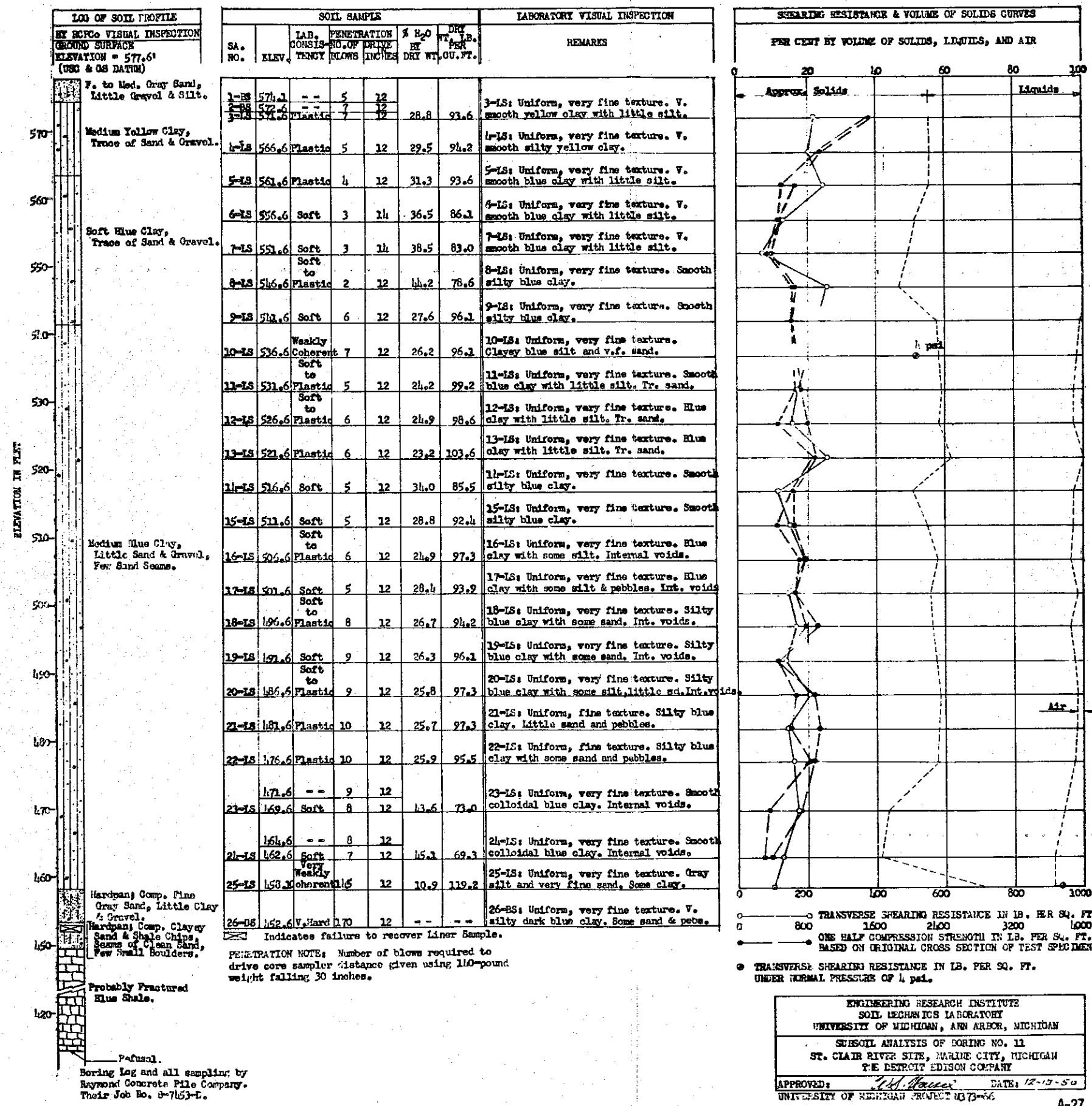
PENETRATION NOTE: Number of blows required to drive core sampler distance given using 140-pound weight falling 30 inches.

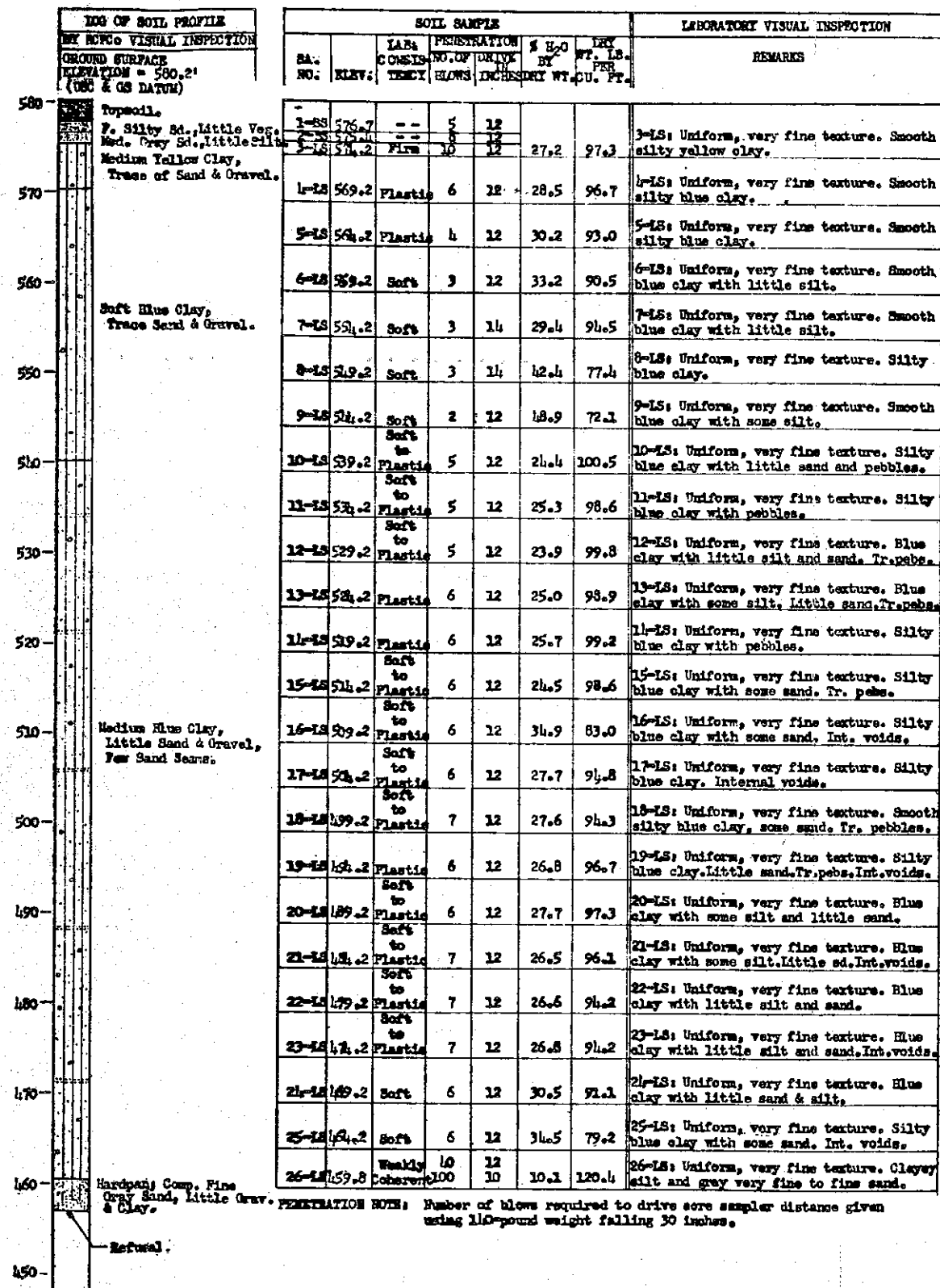
PENETRATION NOTE: Number of blows required to drive core sampler distance given using 140-pound weight falling 30 inches.

Boring Log and all sampling by Raymond Concrete Pile Company. Their Job No. B-7457-D.



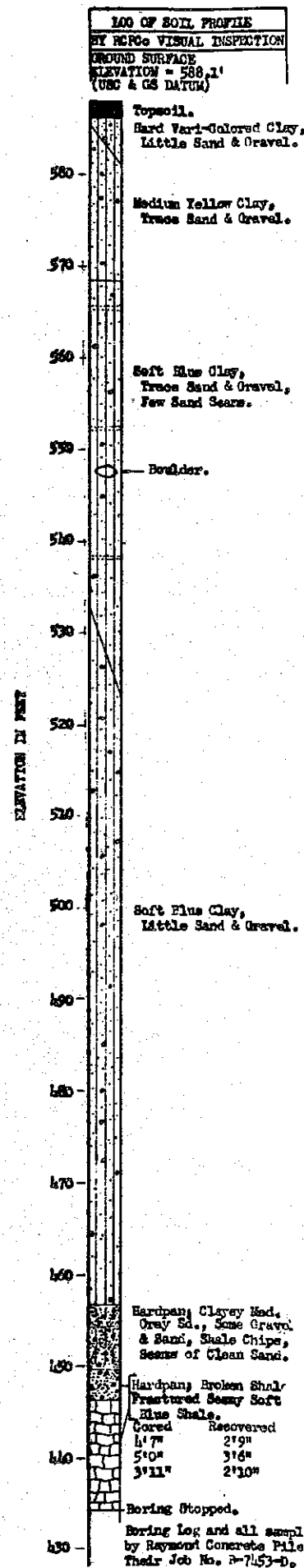
ENGINEERING RESEARCH INSTITUTE
SOIL MECHANICS LABORATORY
UNIVERSITY OF MICHIGAN, ANN ARBOR, MICHIGAN
SUBSOIL ANALYSIS OF BORING NO. 10
ST. CLAIR RIVER SITE, MARINE CITY, MICHIGAN
THE DETROIT EDISON COMPANY
APPROVED: *W. S. Gould* DATE: 12-13-50
UNIVERSITY OF MICHIGAN PROJECT M373-66





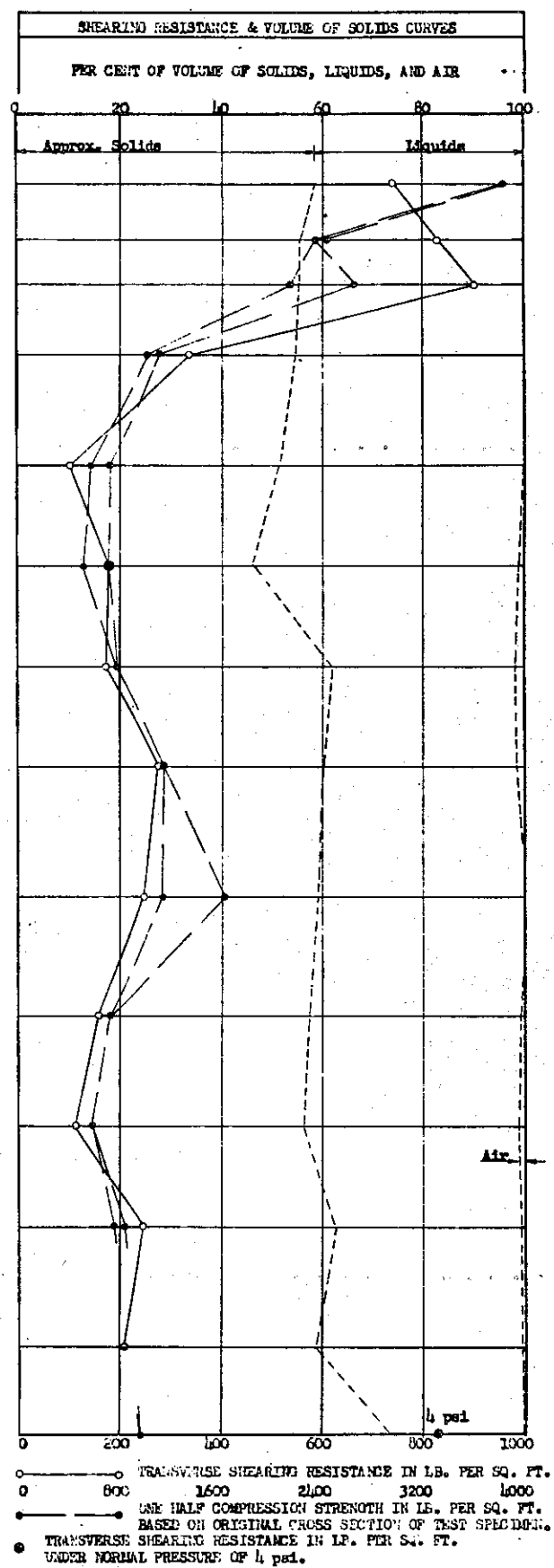
Boring log and all sampling
by Raymond Concrete Pile Company.
Their Job No. D-763-0.

ENGINEERING RESEARCH INSTITUTE
SOIL MECHANICS LABORATORY
UNIVERSITY OF MICHIGAN, ANN ARBOR, MICHIGAN
SUBSOIL ANALYSIS OF BORING NO. 12
ST. CLAIR RIVER SITE, MARIE CITY, MICHIGAN
THE DETROIT EDISON COMPANY
APPROVED: *W. H. Hume* DATE: 12-13-50
UNIVERSITY OF MICHIGAN PROJECT NO. 13-46



SOIL SAMPLE		LABORATORY VISUAL INSPECTION	
SA. NO.	LAB. NO.	REMARKS	
1-LS	585.6	27	12
2-LS	581.1	11	12
3-LS	575.6	7	12
4-LS	571.1	9	13
5-LS	564.1	7	12
6-LS	553.1	3	14
7-LS	543.1	3	14
8-LS	533.1	5	12
9-LS	523.1	7	12
10-LS	513.1	9	12
11-LS	500.1	7	12
12-LS	498.1	7	12
13-LS	487.1	7	12
14-LS	477.1	7	12
15-LS	467.1	7	12
16-LS	455.1	7	12
17-LS	445.1	7	12
18-LS	435.1	7	12
19-LS	425.1	7	12
20-LS	415.1	7	12
21-LS	405.1	7	12
22-LS	395.1	7	12
23-LS	385.1	7	12
24-LS	375.1	7	12
25-LS	365.1	7	12
26-LS	355.1	7	12
27-LS	345.1	7	12
28-LS	335.1	7	12
29-LS	325.1	7	12
30-LS	315.1	7	12
31-LS	305.1	7	12
32-LS	295.1	7	12
33-LS	285.1	7	12
34-LS	275.1	7	12
35-LS	265.1	7	12
36-LS	255.1	7	12
37-LS	245.1	7	12
38-LS	235.1	7	12
39-LS	225.1	7	12
40-LS	215.1	7	12
41-LS	205.1	7	12
42-LS	195.1	7	12
43-LS	185.1	7	12
44-LS	175.1	7	12
45-LS	165.1	7	12
46-LS	155.1	7	12
47-LS	145.1	7	12
48-LS	135.1	7	12
49-LS	125.1	7	12
50-LS	115.1	7	12
51-LS	105.1	7	12
52-LS	95.1	7	12
53-LS	85.1	7	12
54-LS	75.1	7	12
55-LS	65.1	7	12
56-LS	55.1	7	12
57-LS	45.1	7	12
58-LS	35.1	7	12
59-LS	25.1	7	12
60-LS	15.1	7	12
61-LS	5.1	7	12
62-LS	0.1	7	12

PENETRATION NOTE: Number of blows required to drive core sampler distance given using 140-pound weight falling 30 inches.



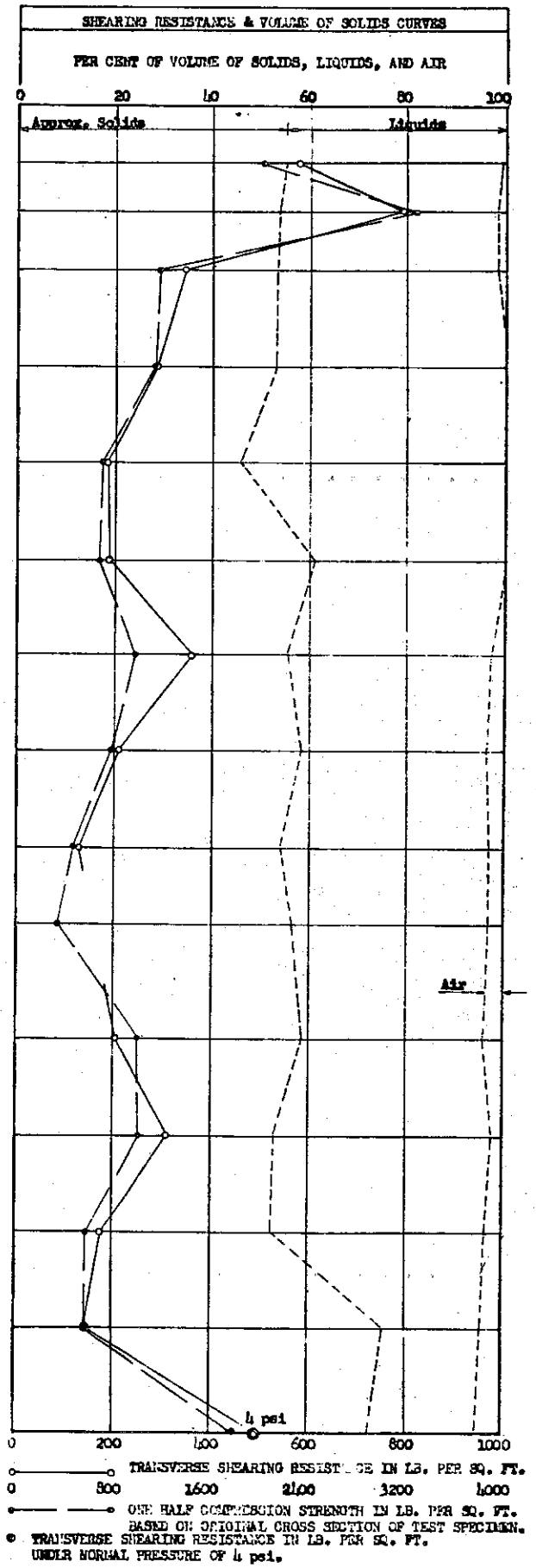
ENGINEERING RESEARCH INSTITUTE
SOIL MECHANICS LABORATORY
UNIVERSITY OF MICHIGAN, ANN ARBOR, MICHIGAN

SUBSOIL ANALYSIS OF BORING NO. 11
ST. CLAIR RIVER SITE, MARINE CITY, MICHIGAN
THE DETROIT EDISON COMPANY

APPROVED: *W. H. Russell* DATE: 12-15-50

LOG OF SOIL PROFILE		SOIL SAMPLE				LABORATORY VISUAL INSPECTION	
BY NCEC VISUAL INSPECTION		BA. NO.	LAB. NO.	PENETRATION	% H ₂ O	DRY WT. LB.	REMARKS
GROUND SURFACE		ELEV. FEET	CONSID. NO. OF BLOW	IN 10 IN. DRIVE	BY	TEST	
ELEVATION = 590.2'							
(USC & GS DATUM)							
590	Med. Vari-colored Clay.	1-LS 586.7	- -	12			2-LS: Uniform, very fine texture. Smooth
	Hard Vari-Colored Clay, Little Sand & Gravel.	2-LS 584.2	Firm	15	29.8	93.0	vari-colored clay with little silt.
580	Medium Yellow Clay, Trace Sand & Gravel.	3-LS 579.2	Stiff	9	30.7	90.5	3-LS: Uniform, very fine texture. Smooth
		4-LS 573.2	Plastic	6	31.2	89.9	yellow clay with little silt.
570		5-LS 563.2	Plastic	5	33.0	89.2	4-LS: Uniform, very fine texture. Smooth
		6-LS 553.2	Soft	5	43.0	77.4	5-LS: Uniform, very fine texture. Smooth
560	Soft Blue Clay, Trace of Sand & Gravel.	7-LS 543.2	Soft	4	36.4	84.9	6-LS: Uniform, very fine texture. Smooth
		8-LS 533.2	Plastic	6	23.9	102.7	blue clay with little silt.
550		9-LS 523.2	Soft to Plastic	7	28.5	93.0	7-LS: Uniform, very fine texture. Smooth
540		10-LS 513.2	Soft	7	24.5	96.0	8-LS: Uniform, very fine texture. Blue
530	Soft Blue Clay, Little Sand & Gravel, Few Sand Beams.	11-LS 505.2	Soft	7	29.4	91.3	9-LS: Uniform, very fine texture. Smooth
520		12-LS 493.2	Plastic	7	26.3	95.5	10-LS: Uniform, very fine texture. Smooth
510		13-LS 483.2	Plastic	9	23.4	99.2	11-LS: Uniform, very fine texture. Smooth
500		14-LS 473.2	Soft	9	31.3	89.2	12-LS: Uniform, very fine texture. Smooth
490	Medium Blue Clay, Trace of Sand & Gravel.	15-LS 463.2	Soft	9	30.7	88.6	13-LS: Uniform, very fine texture. Smooth
480		16-LS 452.2	Firm	90	9.8	127.2	14-LS: Uniform, very fine texture. Smooth
470	Hardpan; Sand. Hardpan; Compact Fine to Med. Gray Sand	17-LS 446.0	- -	200	- -	- -	15-LS: Uniform, very fine texture. Smooth
460	Seams, Clayey Sand with Some Gravel.						16-LS: Uniform, very fine texture. Clayey
450							fine gray sand, little silt.
440	Refusal.						PENETRATION NOTE: Number of blows required to drive core sampler distance given using 140-pound weight falling 30 inches.

Boring Log and all sampling by Raymond Concrete Pile Company. Their Job No. R-763-D.



ENGINEERING RESEARCH INSTITUTE
SOIL MECHANICS LABORATORY
UNIVERSITY OF MICHIGAN, ANN ARBOR, MICHIGAN

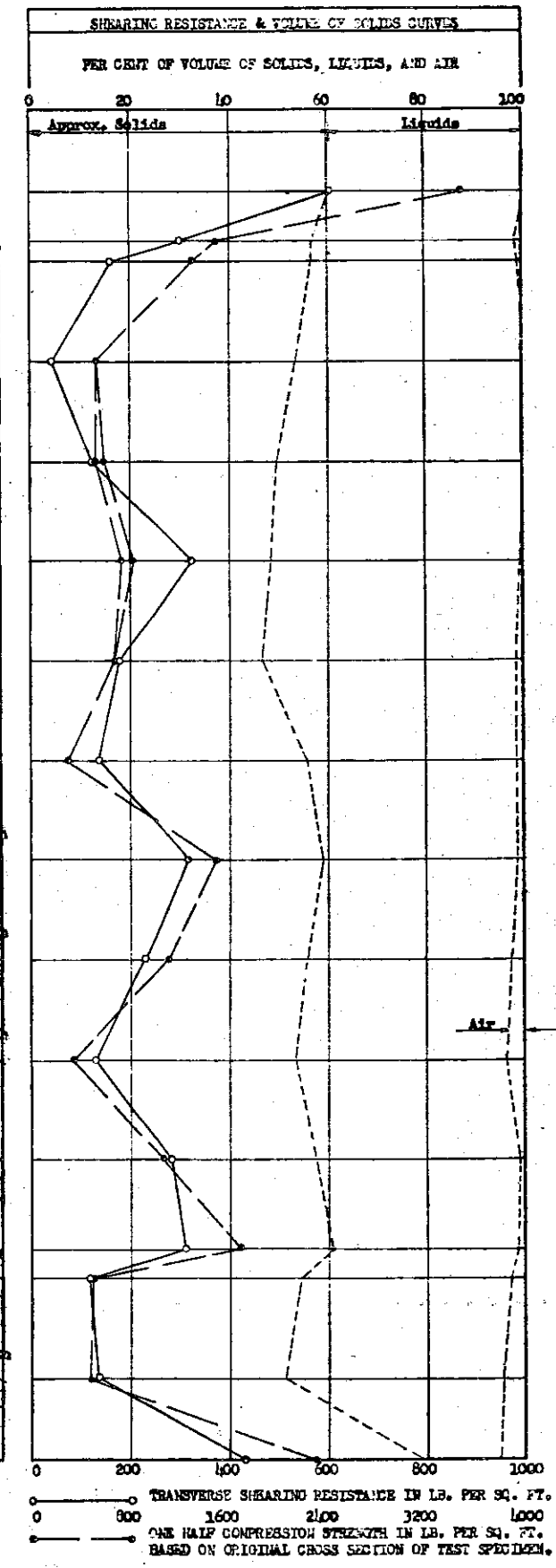
SUBSOIL ANALYSIS OF BORING NO. 15
ST. CLAIR RIVER SITE, MARINE CITY, MICHIGAN
THE DETROIT EDISON COMPANY

APPROVED: *W. H. Howard* DATE: 2-12-54
UNIVERSITY OF MICHIGAN PRINTED 1973-66

TOP OF SOIL PROFILE		SOIL SAMPLE				LABORATORY VISUAL INSPECTION	
BY ROUTE VISUAL INSPECTION		SA. NO.	LAP. NO.	NO. OF BLOWS	W. OF DRIVE FT.	DRY UNIT WT. Lb. per cu. ft.	REMARKS
GROUND SURFACE ELEVATION = 589.1' (USC & GS DATUM)							
Med. Vari-colored Clay, Med. Hard V. Colored Clay, Little Sand & Gravel.		1-15	585.6	--	15	12	
Hard Yellow Clay, Trace Sand & Gravel.		2-15	581.1	Stiff Plastic	20	12	24.4 102.3
Med. Yellow Clay, Trace Sand & Gravel.		3-15	576.1	Firm	8	12	26.9 96.7
		4-15	571.1 to 571.1		6	13	27.9 95.5
		5-15	566.1	V. Soft	4	12	32.8 89.9
		6-15	561.1	Soft	3	12	37.8 83.6
Soft Blue Clay, Trace of Sand & Gravel.		7-15	556.1	Soft to Plastic	3	13	39.9 81.1
		8-15	551.1	Soft	3	12	41.9 78.0
		9-15	546.1	Soft	5	12	28.5 93.6
		10-15	541.1	Plastic	7	12	25.1 99.2
		11-15	536.1	Plastic	7	12	27.8 93.6
Soft Blue Clay, Little Sand & Gravel.		12-15	531.1	Soft	7	12	29.7 89.9
		13-15	526.1	Plastic	7	12	26.9 96.7
Sandy Med. Blue Clay, Little Gravel.		14-15	521.1	Plastic	17	12	23.1 101.7
		15-15	516.1	Soft	9	12	29.1 91.1
Med. Blue Clay, Little Sand & Gravel.		16-15	511.1	Soft	9	12	32.2 86.1
Hardpan, Comp. Clayey F. to C. Grey Sd. & Gr.		17-15	506.1	Firm to Stiff	37	12	7.5 132.9
Hardpan, V. Comp. Fine Grey Sd., Little Cl. & Gr. Broken Shale in Bottom of Spoon.		18-15	501.1	--	200	6	
Boring Stopped.		19-15	496.1	--	200	4	--

ELEVATION IN FEET
 580
570
560
550
540
530
520
510
500
490
480
470
460
450
440

PENETRATION NOTE: Number of blows required to
 drive core sampler distance given using 140-
 pound weight falling 30 inches.



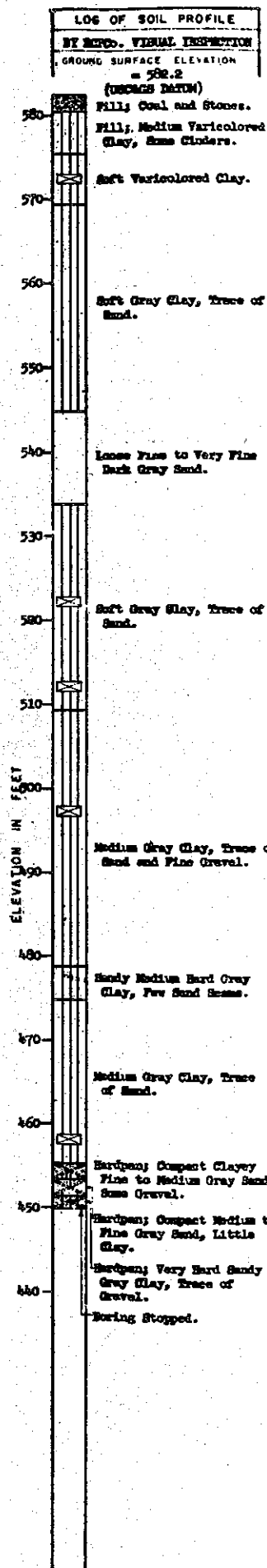
Boring log and all sampling
 by Raymond Concrete Pile Company.
 Their Job No. B-7453-D.

ENGINEERING RESEARCH INSTITUTE
 SOIL MECHANICS LABORATORY
 UNIVERSITY OF MICHIGAN, ANN ARBOR, MICHIGAN

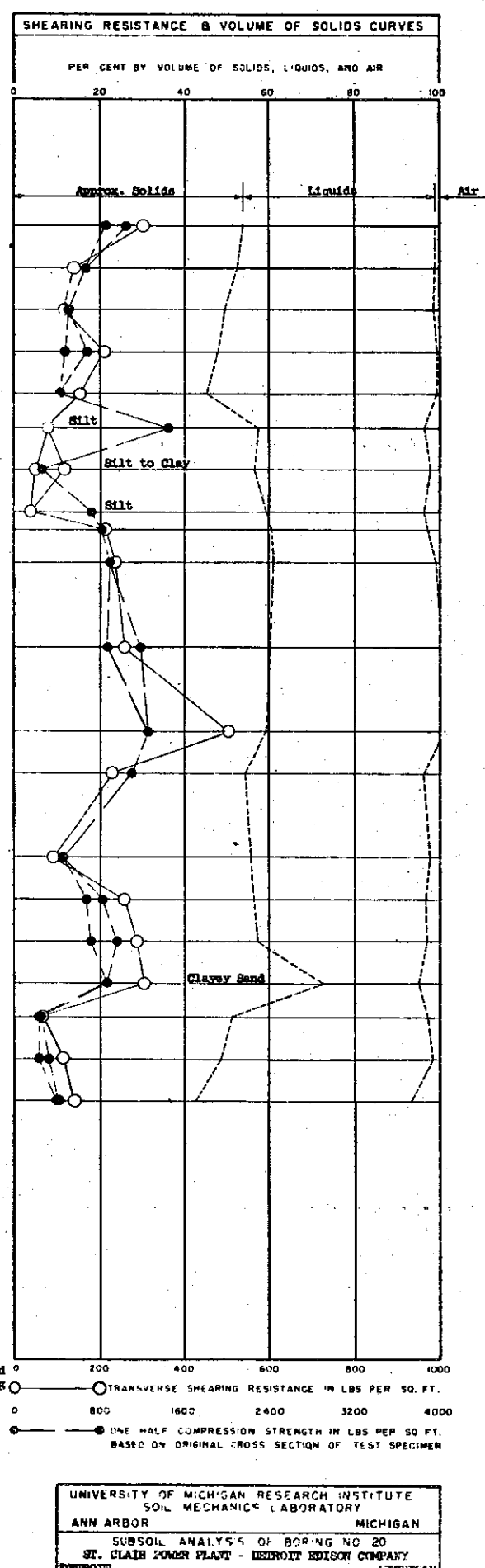
SUBSOIL ANALYSIS OF BORING NO. 16
 ST. CLAIR RIVER SITE, MARINE CITY, MICHIGAN
 THE DETROIT EDISON COMPANY

APPROVED: *W. H. Housner* DATE: 2-13-50

UNIVERSITY OF MICHIGAN PROJECT NO. 16



SOIL SAMPLE						LABORATORY VISUAL INSPECTION	
SA NO.	ELEV.	LAB. CONSISTENCY	PENETRATION NO. OF BLOWS DRIVE IN INCHES	% H ₂ O BY DRY WT.	DRY WT. LB. PER CU. FT.	REMARKS	
1-B	579.2	--	5	12			
2-B	576.2	--	5	12			
3-B	572.2	--	4	12			
4-B	567.2	Plastic	4	12	30.9	91.1	4-B: Uniform. Gray clay, some silt, trace of sand.
5-B	562.2	Soft	2	14	32.6	89.2	5-B: Uniform. Gray clay, some silt, trace of sand.
6-B	557.2	Soft	2	14	37.1	83.0	6-B: Uniform. Gray clay, some silt, trace of sand.
7-B	552.2	Soft	2	16	40.3	80.5	7-B: Uniform. Gray clay, some silt, trace of sand.
8-B	547.2	Soft	2	15	45.0	76.1	8-B: Uniform. Gray clay, some silt, trace of sand.
9-B	543.2	Plastic	8	12	25.4	95.5	9-B: Uniform. Clayey gray silt, little sand.
10-B	538.2	Very Soft	5	12	27.6	93.9	10-B: Non-uniform. Varies from silty gray clay, trace of sand to clayey gray silt, little sand.
11-B	533.2	Soft	6	12	23.1	99.2	11-B: Uniform. Clayey gray silt, little sand.
12-B	531.2	Plastic	4	12	22.7	101.1	See Note A.
13-B	527.2	Plastic	4	13	23.3	101.7	13-B: Uniform. Silty gray clay, some sand, trace of gravel.
14-B	522.2	--	4	12			
15-B	517.2	Plastic	5	14	24.9	99.8	15-B: Uniform. Silty gray clay, some sand, trace of gravel.
	512.2	--	4	12			
16-B	507.2	Plastic	8	13	25.9	100.5	16-B: Uniform. Gray clay, some silt, trace of sand and gravel.
17-B	502.2	Plastic	7	13	26.0	93.0	17-B: Uniform. Gray clay, some silt, trace of sand and gravel.
	497.2	--	7	12			
18-B	492.2	Soft	7	12	27.3	94.3	18-B: Uniform. Gray clay, some silt, trace of sand and gravel.
19-B	487.2	Soft to Plastic	7	12	26.4	95.5	19-B: Uniform. Gray clay, some silt, trace of sand and gravel.
20-B	482.2	Soft to Plastic	8	12	25.7	96.7	20-B: Uniform. Gray clay, some silt, trace of sand and gravel.
21-B	477.2	Soft to Plastic	17	12	11.3	123.6	21-B: Non-uniform. Varies from silty gray clay to clayey silty gray sand.
22-B	473.2	Very Soft	8	12	33.3	86.1	22-B: Uniform. Gray clay, some silt, trace of sand and gravel.
23-B	468.2	Soft	7	12	38.0	82.4	23-B: Uniform. Gray clay, some silt, trace of sand.
24-B	463.2	Soft	6	12	45.0	70.5	24-B: Uniform. Gray clay, trace of silt and sand.
	458.2	--	7	12			
25-B	454.1	--	72	12			
26-B	451.7	--	36	12			
27-B	449.9	--	106	12			
PENETRATION NOTE: Number of blows required to drive core sampler distance given on a 140-pound weight falling 30 inches.							
Note A							
12-B: Uniform. Silty gray clay, some sand, trace of gravel.							

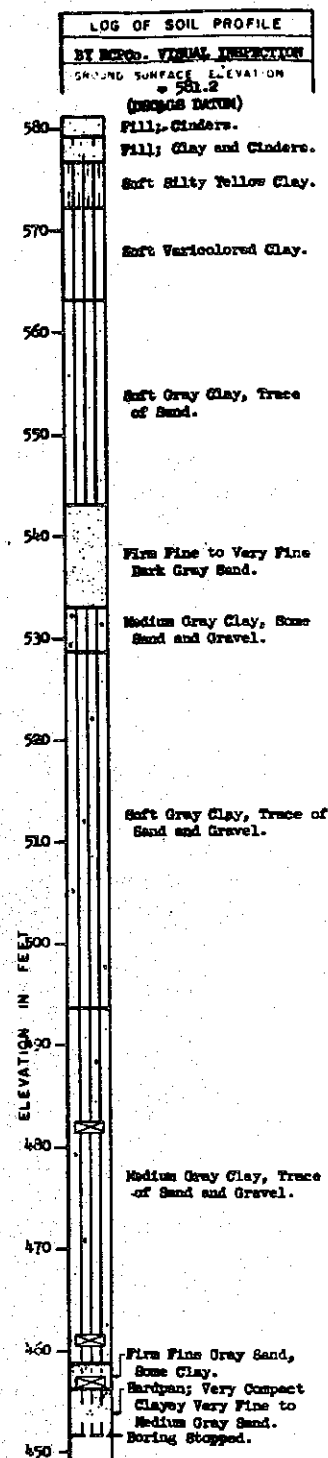


Boring Log and all sampling by Raymond Concrete Pile Company. Their Job No. B-25056-B.

Indicates failure to recover liner sample

NOTE: Permanent Ground Water Level assumed to be the level of the St. Clair River adjacent to the site.

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SOIL MECHANICS LABORATORY
ANN ARBOR MICHIGAN
SUBSOIL ANALYSIS OF BORING NO. 20
ST. CLAIR POWER PLANT - DETROIT EDISON COMPANY
DETROIT MICHIGAN
APPROVED: [Signature] DATE: 4-2-59
UNIVERSITY OF MICHIGAN RESEARCH INSTITUTE PROJECT 01594



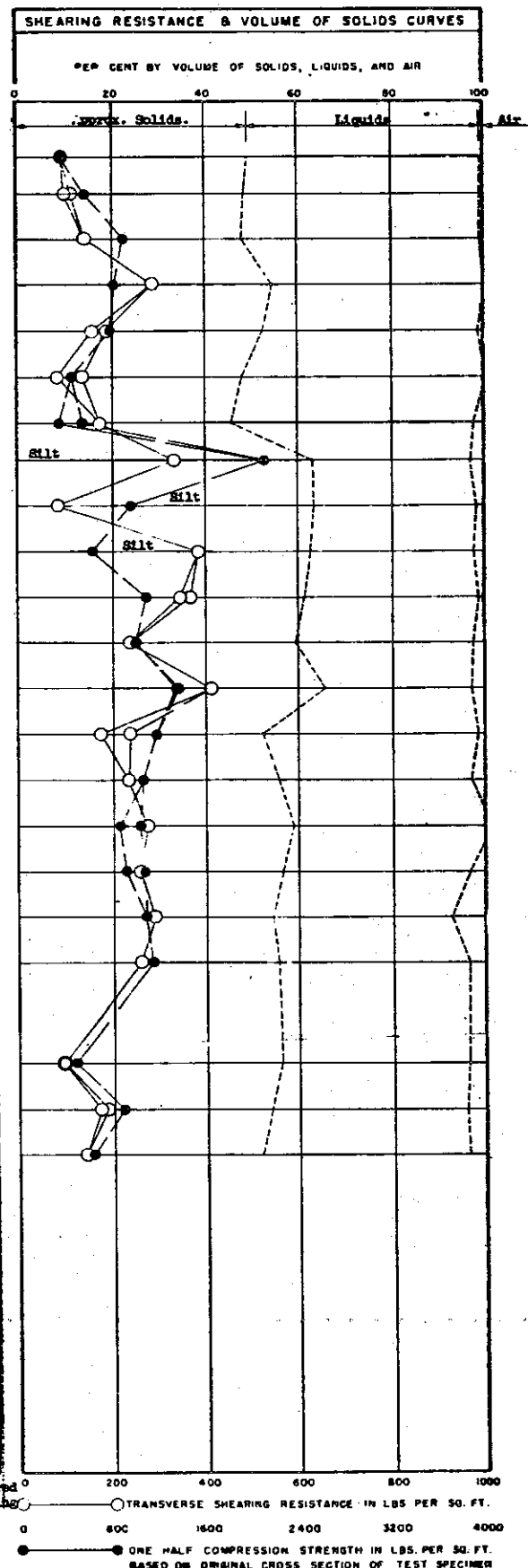
Boring log and all sampling by Raymond Concrete Pile Company. Their Job No. B-25056-D.

SOIL SAMPLE					LABORATORY VISUAL INSPECTION	
SA NO.	ELEV.	LAB. CONSISTENCY	PENETRATION NO. OF DRIVE IN BLOWS INCHES	% H ₂ O DRY WT.	DRY WT. LBS PER CU. FT.	REMARKS
1-BE	579.2	--	5	12		1-LB: Uniform. Yellow clay, some silt, trace of sand.
2-BE	577.2	--	5	12		
3-LB	575.2	Soft	2	12	38.2	83.0
4-LB	571.2	Soft	2	15	39.3	81.4
5-LB	566.2	Soft	2	12	37.9	81.1
6-LB	561.2	Plastic	3	14	30.7	92.4
7-LB	556.2	Soft	3	14	32.6	86.6
8-LB	551.2	Soft	2	18	40.4	81.1
9-LB	546.2	Soft	2	16	42.8	76.8
10-LB	542.1	Firm	18	12	20.2	104.8
11-LB	537.2	Plastic	11	12	20.8	105.5
12-LB	532.2	Plastic	7	13	21.4	103.6
13-LB	527.2	Plastic	5	14	23.2	101.7
14-LB	522.2	Plastic	4	12	24.0	99.2
15-LB	517.2	Plastic	5	12	18.0	109.2
16-LB	512.2	Plastic	5	12	33.8	85.8
17-LB	507.2	Plastic	5	13	27.2	94.8
18-LB	502.2	Plastic	4	12	26.7	99.8
19-LB	497.2	Plastic	5	12	26.1	96.1
20-LB	492.2	Plastic	6	12	26.0	92.4
21-LB	487.2	Plastic	8	12	27.2	94.2
22-BE	482.2	--	7	12		
23-LB	476.2	Soft	7	12	26.5	95.2
24-LB	471.2	Soft to Plastic	7	12	28.7	91.4
25-LB	466.2	Soft	7	12	31.8	88.0
	461.2	--	7	12		
26-BE	457.2	--	12	12		
	455.2	--	100	8		
27-BE	451.2	--	100	4		

PENETRATION NOTE: Number of blows required to drive core sampler distance given using a 140-pound weight falling 30 inches.

Note A

5-LB: Uniform. Mottled yellow and gray clay, some silt, trace of sand with pocket of clayey gray silt, trace of organic matter.



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SOIL MECHANICS LABORATORY
ANN ARBOR MICHIGAN

SUBSOIL ANALYSIS OF BORING NO. 21
ST. CLAIR POWER PLANT - DETROIT EDISON COMPANY
DETROIT MICHIGAN

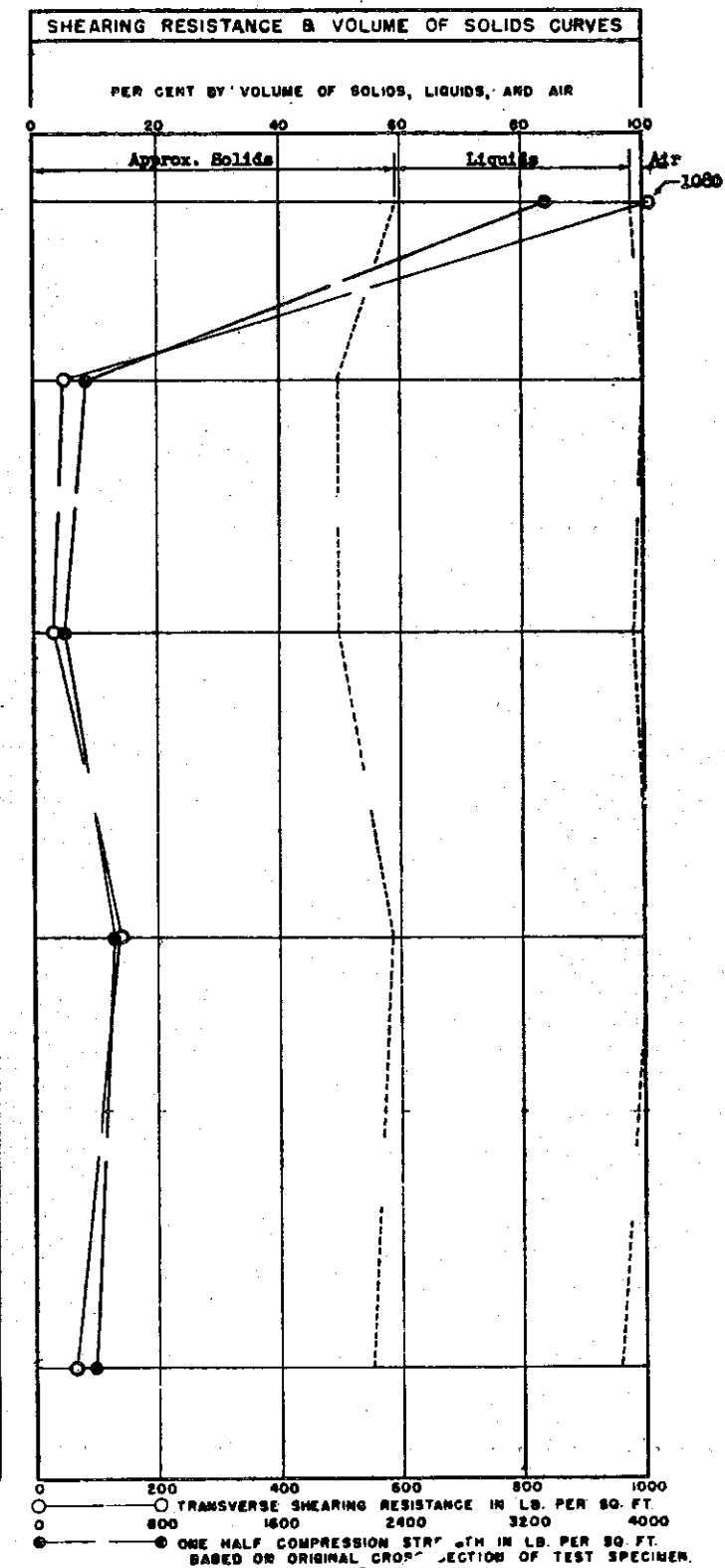
APPROVED: *[Signature]* DATE: 11-2-57

UNIVERSITY OF MICHIGAN RESEARCH INSTITUTE PROJECT 01994

LOG OF SOIL PROFILE
BY H.C.P. DIVISION
GROUND SURFACE
ELEVATION = 588.60 Ft.
(USING USC & GS DATUM)

ELEVATION IN FEET	SOIL DESCRIPTION	TEST NO.	DEPTH (FEET)	WATER CONTENT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX	UNIFORMITY COEFFICIENT	COEFFICIENT OF CURVATURE	SOIL DESCRIPTION
580	Stiff Sandy Varicolored Clay.	1-BB	586.1	--	16	12			2-LS: Uniform. Silty mottled brown-gray clay.
		2-LS	583.1	Stiff	15	12	24.2	99.2	
	Medium Sandy Brown Clay	3-BB	578.6	--	10	12			
		4-BB	573.1	--	5	12			
570		5-LS	568.6	Very Soft	4	12	37.4	84.2	5-LS: Uniform. Silty gray clay, trace of very fine sand.
		6-BB	563.6	--	2	12			
560		7-BB	558.1	--	2	11			
		8-BB	553.1	--	2	11			
550	Soft Gray Clay, Some Sand, Trace of Gravel.	9-LS	548.1	Very Soft	3	13	35.0	86.7	9-LS: Uniform. Silty gray clay.
		10-BB	543.1	--	2	12			
540		11-BB	538.1	--	2	12			
		12-BB	533.1	--	3	12			
530		13-BB	528.6	--	6	12			
		14-LS	523.1	Soft	9	12	26.8	98.6	14-LS: Uniform. Silty gray clay, trace of sand and gravel.
520		15-BB	518.6	--	10	12			
		16-BB	513.6	--	11	12			
510		17-BB	508.6	--	12	12			
		18-BB	503.6	--	13	12			
500		19-BB	498.6	--	14	12			
	Medium Gray Clay, Some Sand, Trace of Gravel.	20-BB	493.1	--	11	12			
490		21-LS	488.1	Very Soft	9	12	27.3	93.0	21-LS: Uniform. Silty gray clay, trace of sand and gravel.
		22-BB	483.6	--	10	12			
480		23-BB	478.6	--	10	12			
		24-BB	473.6	--	10	12			
470		25-BB	468.6	--	10	12			
		26-BB	463.6	--	10	12			
460		27-BB	458.6	--	8	12			
		28-BB	453.4	--	100	5			
450	Very Compact Medium Clayey Gray Sand. Boring Stopped.								

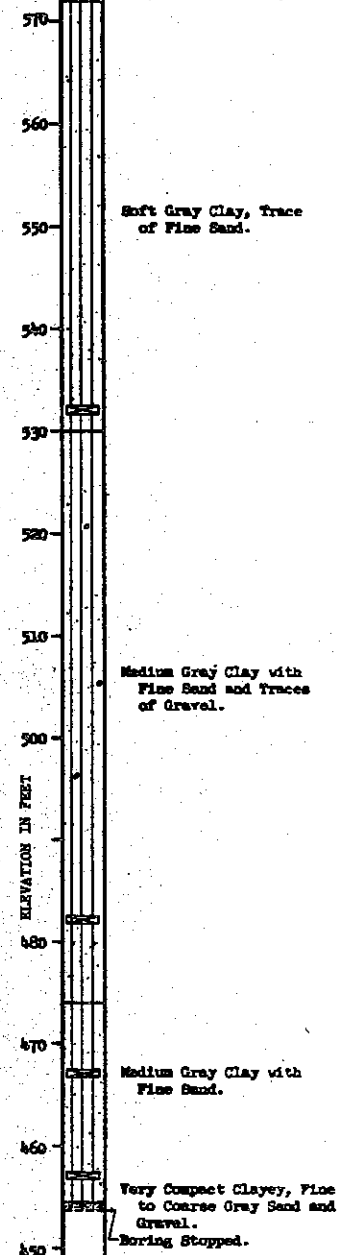
REMARKS: Number of blows required to drive core sampler distance given using a 140-pound weight falling 30 inches.



ENGINEERING RESEARCH INSTITUTE SOIL MECHANICS LABORATORY UNIVERSITY OF MICHIGAN, ANN ARBOR, MICHIGAN	
SUBSOIL ANALYSIS OF BORING NO. 29 CAR DUMPER HOUSE - ST. CLAIR POWER PLANT THE DETROIT EDISON CO. BELLE RIVER, MICHIGAN	
APPROVED: <i>W. H. Hines</i>	DATE: 6-14-67 PROJECT: 01994

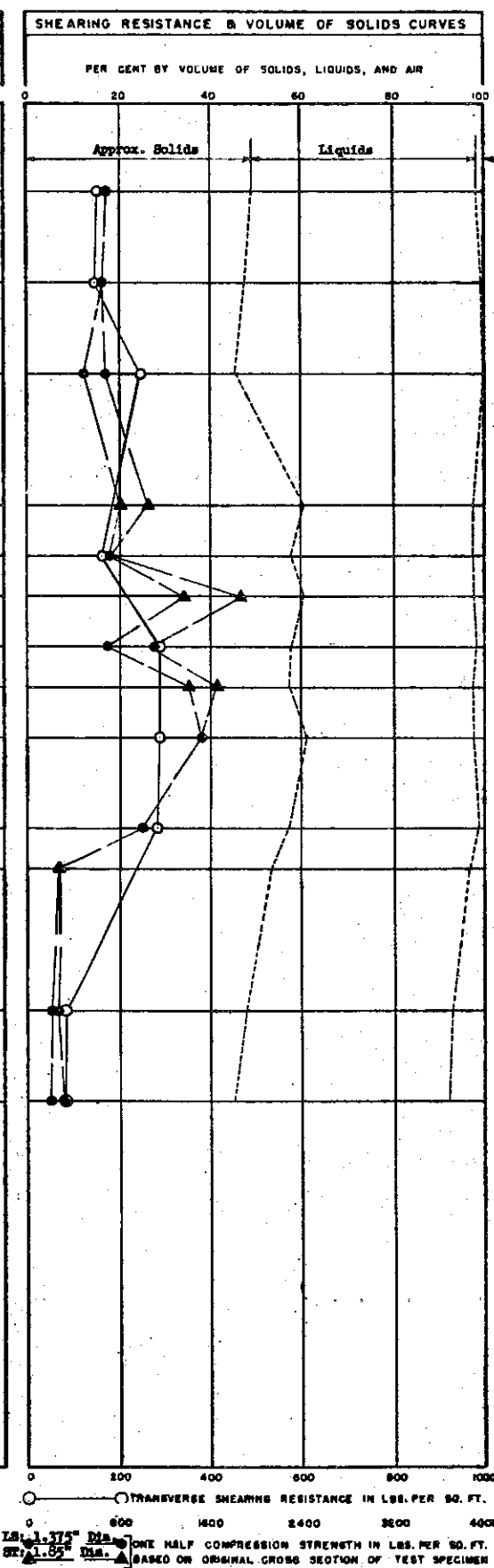
Boring Log and all Sampling
by Raymond Concrete Pile
Division of Raymond
International, Inc.
Their Job No. RCE-11914-D.
Date of Boring: 12-20-66.

LOG OF SOIL PROFILE
BY R.C.P. DIVISION
GROUND SURFACE ELEVATION
= 572 Ft.
(USING USC & GS DATUM)



SOIL SAMPLE		LABORATORY VISUAL INSPECTION	
SA NO.	ELEV.	CONSI- STENCY	REMARKS
1-SS	567.0	--	3 12
2-LS	562.0	Soft	2 12 36.7 84.2
Lost SS	557.0	--	2 12
3-LS	552.0	Soft	2 12 39.5 81.7
4-SS	547.0	--	2 12
5-LS	542.0	Soft	3 12 44.3 76.1
6-SS	537.0	--	3 12
Lost LS	532.0	--	3 12
7-ST	527.0	Soft	Pushed 22.6 102.1
8-LS	522.0	Soft	8 12 25.7 97.3
9-ST	517.0	Plastic	Pushed 22.8 102.3
10-LS	512.0	Soft to Plastic	9 12 26.2 97.3
11-ST	507.0	Plastic	Pushed 25.9 96.7
12-LS	502.0	Plastic	13 12 21.9 103.6
Lost ST	497.0	--	Pushed
13-LS	492.0	Plastic	11 12 26.8 96.7
14-ST	487.0	Very Soft	Pushed 29.7 91.1
Lost LS	482.0	--	10 12
Lost ST	477.0	--	Pushed
Lost ST	472.0	--	Pushed
15-LS	472.0	Very Soft	13 12 34.5 81.4
16-BS	467.0	--	14 12
17-LS	462.0	Very Soft	14 12 38.2 77.1
Lost LS	457.0	--	14 12
18-SS	453.7	--	100 10

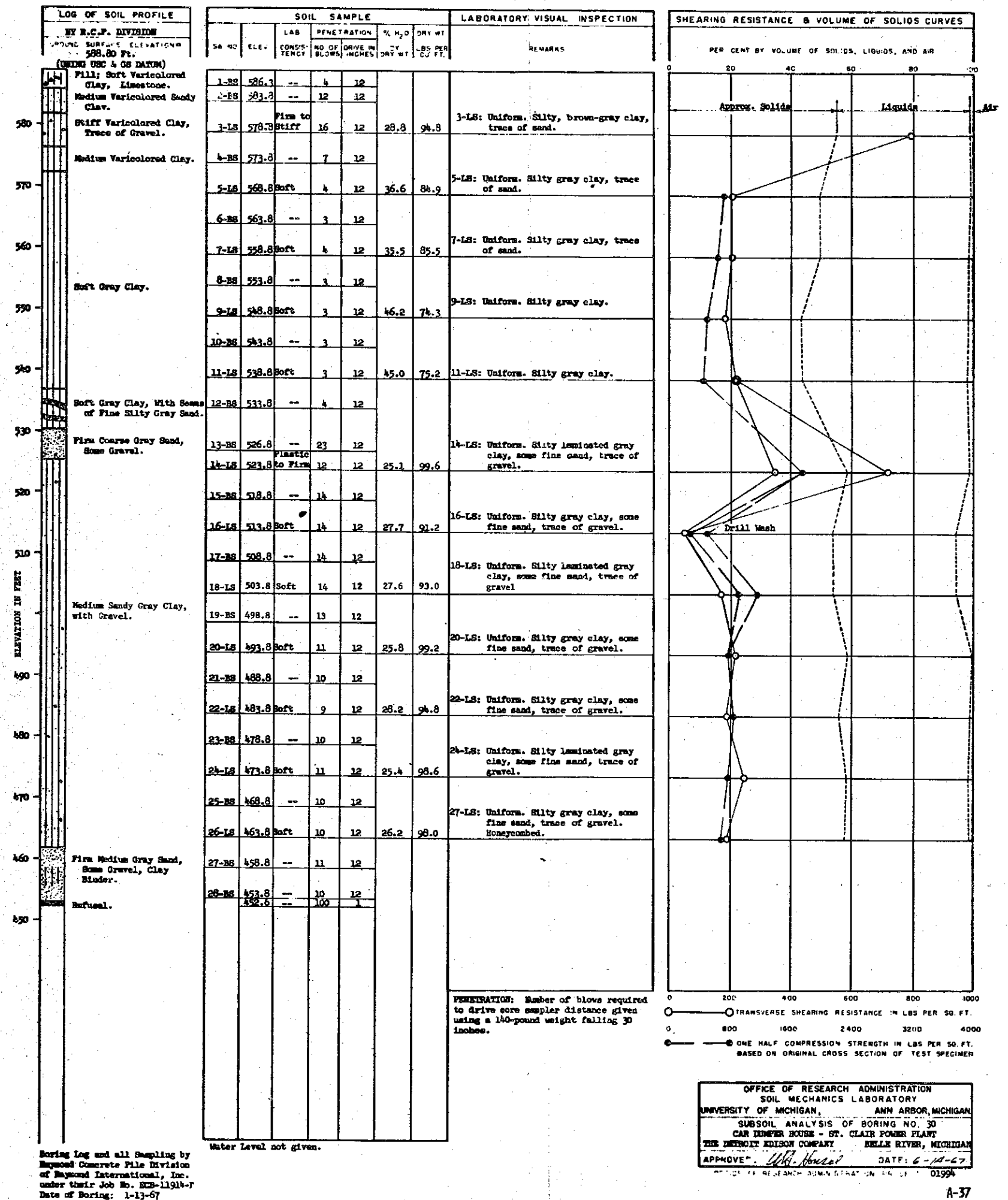
Penetration: Number of blows required to drive core sampler distance given using a 140-pound weight falling 30 inches.



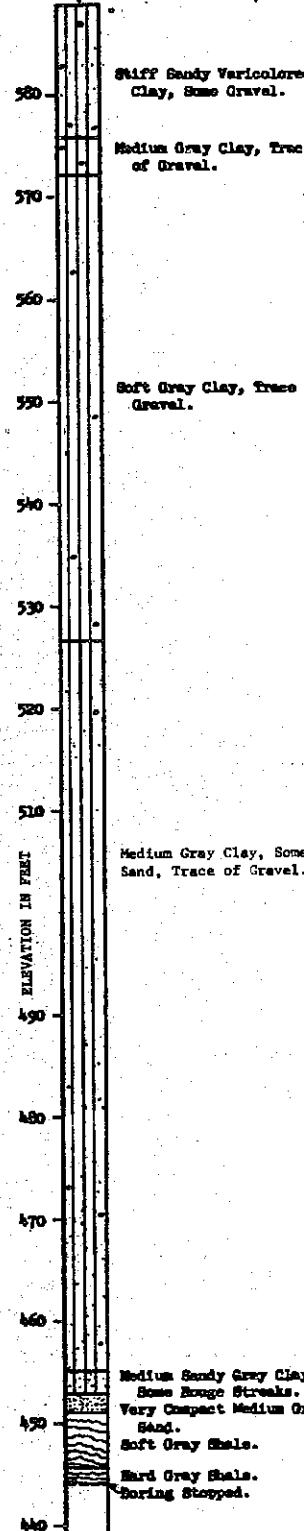
Boring Log and all sampling by Raymond Concrete Pile Division of Raymond International, Inc. under their Job No. RC-11914-D. Date of Boring: 2-11-67

LS: Undisturbed Liner Sample 1.375" diameter.
SS: Disturbed Sample.
ST: Undisturbed Shelby Tube Sample 1.85" diameter.
BS: Standard Spoon Sample.
Water Level Not Given.

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SOIL MECHANICS LABORATORY
UNIVERSITY OF MICHIGAN, ANN ARBOR, MICHIGAN
SUBSOIL ANALYSIS OF BORING NO. 29A
GAR HUNTER HOUSE - ST. CLAIR POWER PLANT
DETROIT EDISON COMPANY, BELLE RIVER, MICHIGAN
APPROVED: *[Signature]* DATE: 6-14-67
OFFICE OF RESEARCH ADMINISTRATION PROJECT 01994

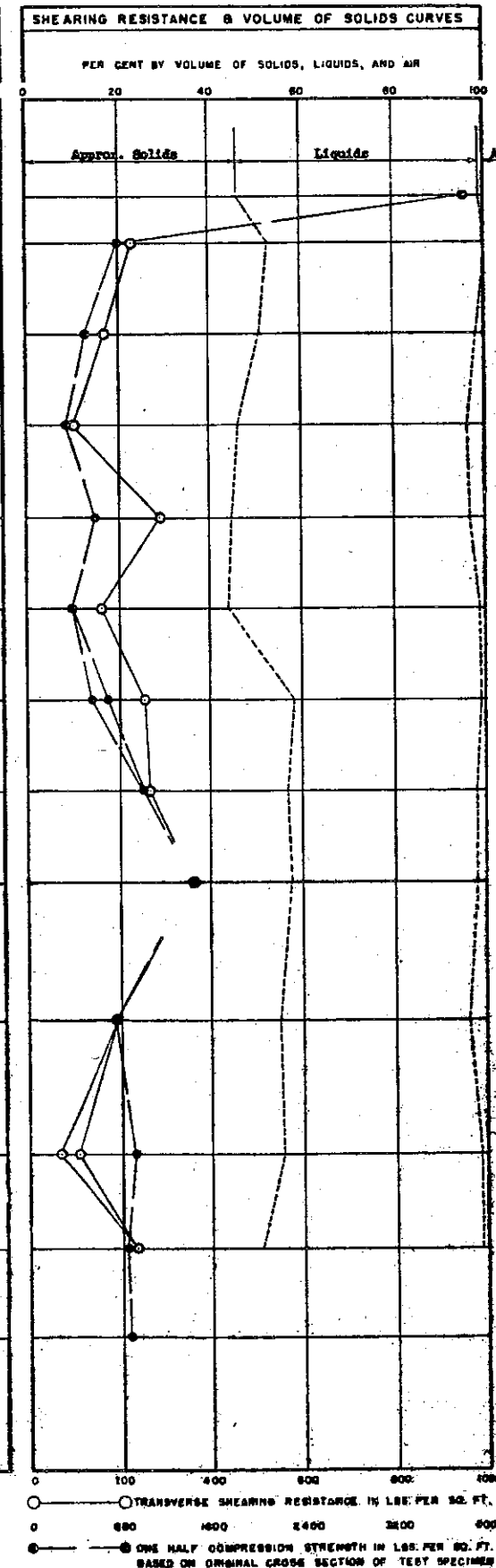


LOG OF SOIL PROFILE
BY R.C.P. DIVISION
GROUND SURFACE ELEVATION
= 588.80 Ft.
(USING UMC & GS DATUM)



SOIL SAMPLE		LABORATORY VISUAL INSPECTION	
SA. NO.	ELEV.	LAB. COMMENTS	REMARKS
1-BB	586.3	21 12	
2-BB	581.8	22 12	
3-LB	578.3	17 12	41.7 79.2 3-LB: Uniform. Silty varicolored clay.
4-LB	573.3	5 12	32.5 91.1 4-LB: Uniform. Silty gray clay.
5-BB	568.8	3 11	
6-LB	563.3	3 12	33.3 88.0 6-LB: Uniform. Silty gray clay.
7-BB	558.8	3 12	
8-LB	553.3	4 12	38.5 81.1 8-LB: Uniform. Silty gray clay.
9-BB	548.3	4 12	
10-LB	543.3	4 12	42.1 77.4 10-LB: Uniform. Silty gray clay.
11-BB	538.8	4 12	
12-LB	533.3	4 12	45.1 76.1 12-LB: Uniform. Silty gray clay.
13-BB	528.8	4 12	
14-LB	523.3	6 12	25.9 98.6 14-LB: Uniform. Silty gray clay, trace of sand and gravel.
15-BB	518.8	9 12	
16-LB	513.3	10 12	26.7 96.1 16-LB: Uniform. Silty laminated gray clay, trace of sand and gravel.
17-BB	508.8	10 12	
18-LB	503.3	11 12	26.6 97.3 18-LB: Uniform. Silty laminated gray clay, trace of sand and gravel.
19-BB	498.8	10 12	
20-LB	493.3	11 12	
21-LB	488.8	2 12	27.7 93.0 20-LB: Uniform. Silty gray clay, trace of sand and gravel. Honeycombed.
22-LB	483.3	16 12	
23-LB	478.8	9 12	28.6 94.0 21-LB: Uniform. Silty gray clay, some sand, trace of gravel.
24-LB	473.3	14 12	
25-LB	468.8	8 12	34.7 86.1 23-LB: Uniform. Silty gray clay, trace of sand. Honeycombed.
26-LB	463.3	9 12	
27-LB	458.8	12 12	17.4 -- 25-LB: Non-uniform. Silty sandy gray clay. Honeycombed.
28-BB	453.3	10 12	
29-BB	448.8	200 3	
30-BB	443.3	200 1	

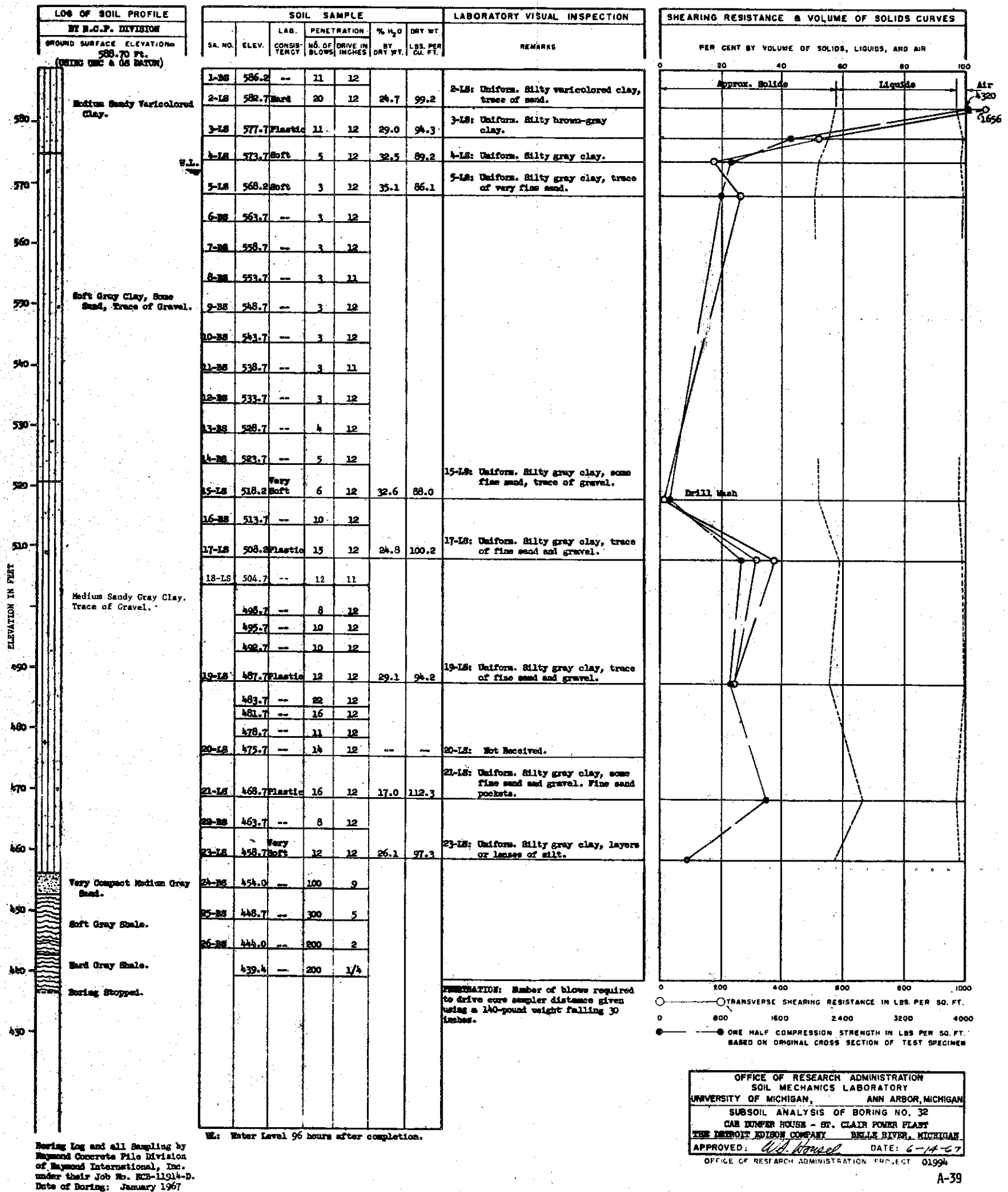
Penetration: Number of blows required to drive core sampler distance given using a 140-pound weight falling 30 inches.

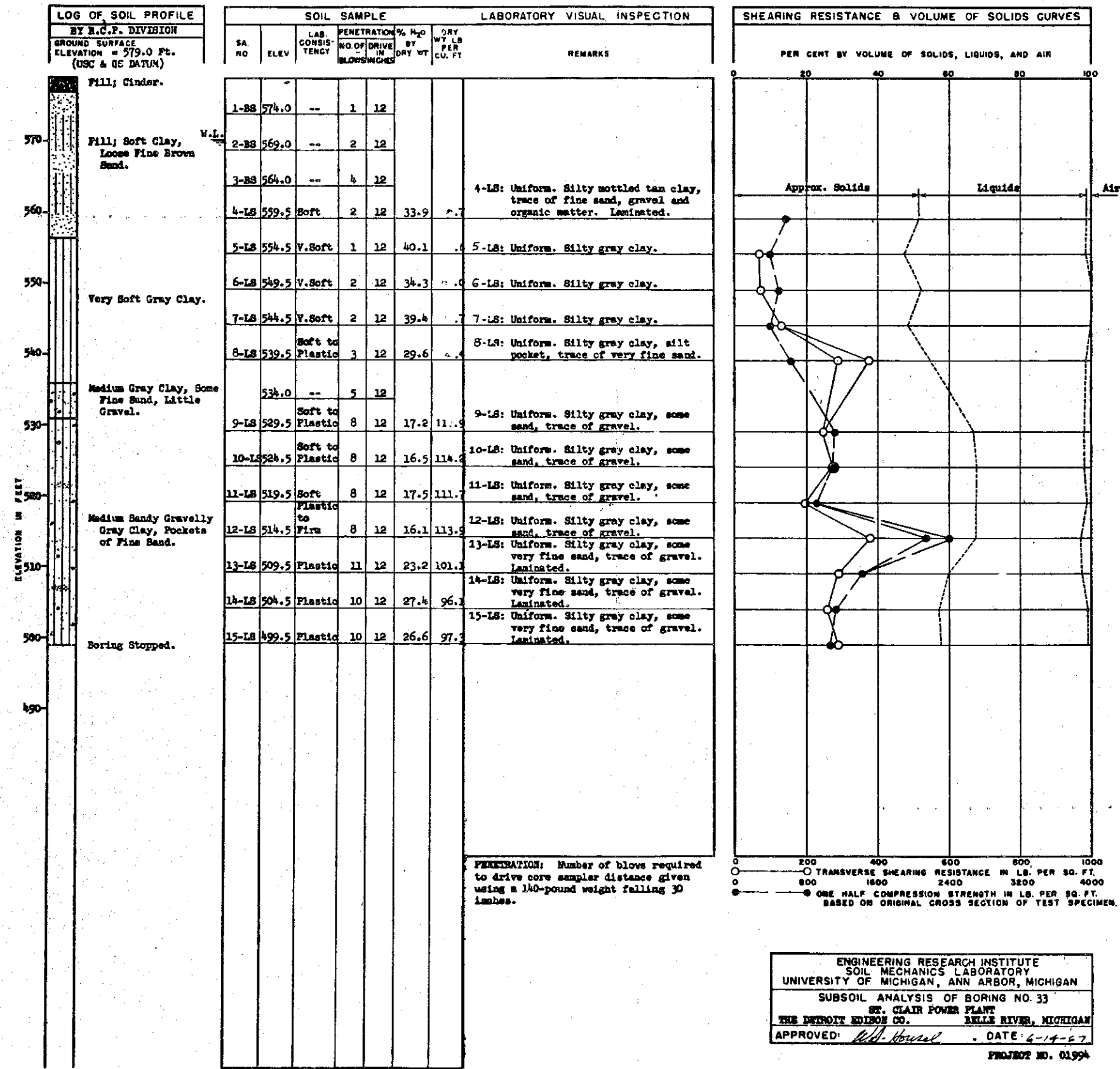


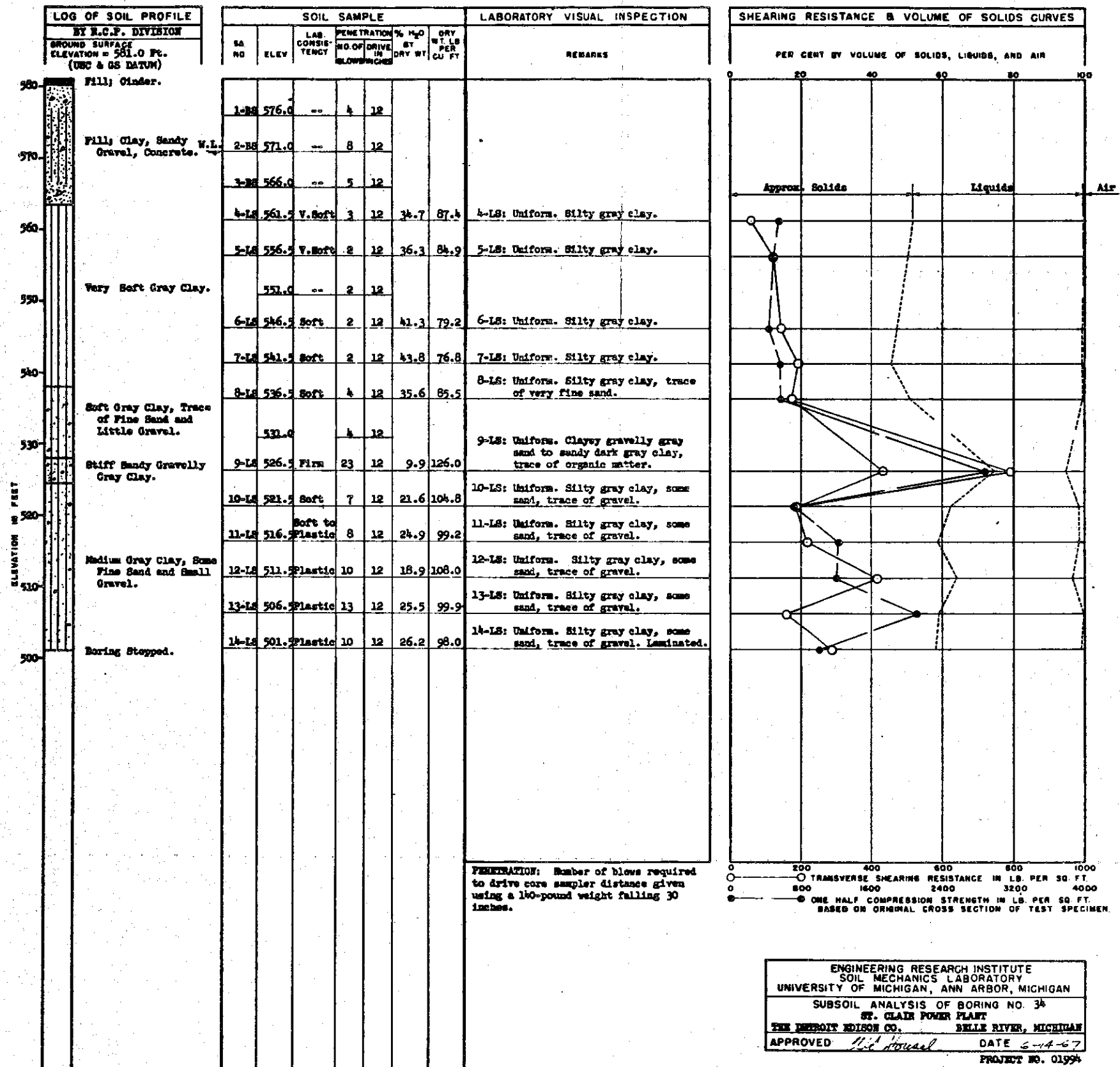
Boring Log and all sampling by Raymond Concrete Pile Division of Raymond International, Inc. under their Job No. RCB-11914-D. Date of Boring: December 1966 to January 1967

WL: Water Level 24 hours after completion.

OFFICE OF RESEARCH ADMINISTRATION
SOIL MECHANICS LABORATORY
UNIVERSITY OF MICHIGAN, ANN ARBOR, MICHIGAN
SUBSOIL ANALYSIS OF BORING NO. 31
GAR DUMPER HOUSE - ST. CLAIR POWER PLANT
THE DETROIT Edison COMPANY, BELLE RIVER, MICHIGAN
APPROVED: *W.A. Howard* DATE: 6-14-67
OFFICE OF RESEARCH ADMINISTRATION PROJECT 01994



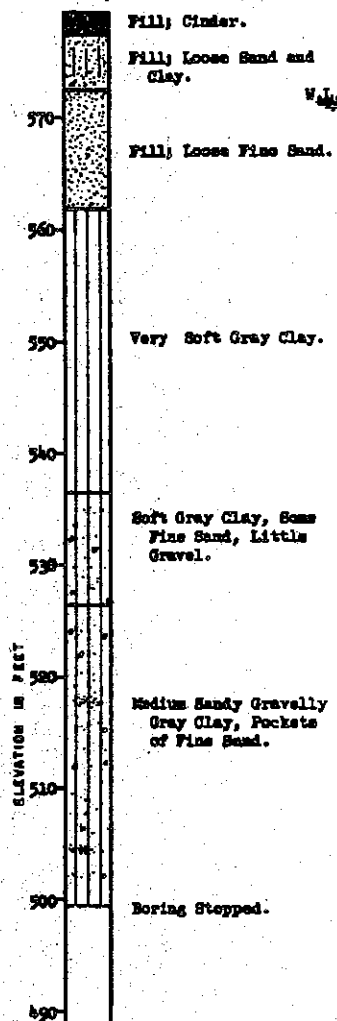




LOG OF SOIL PROFILE

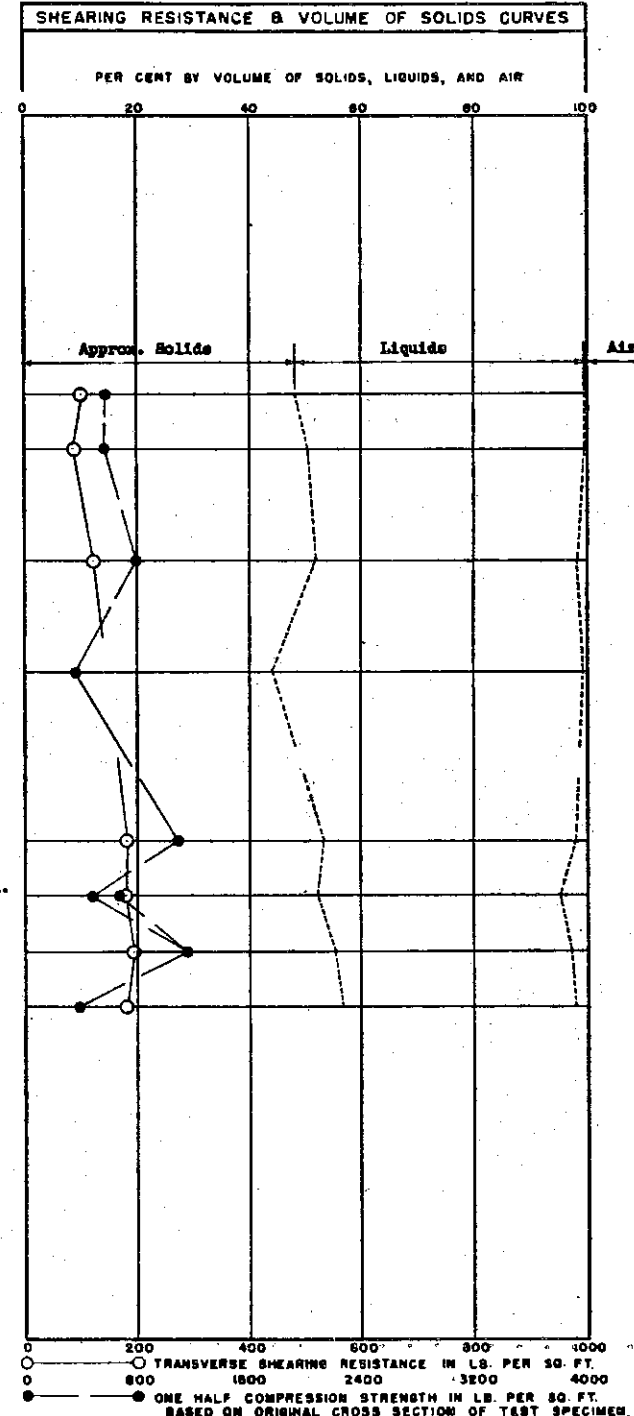
BY R.G.P. DIVISION

GROUND SURFACE ELEVATION = 579.4 Ft. (USC & GS DATUM)



SOIL SAMPLE		LABORATORY VISUAL INSPECTION			
SA NO.	ELEV.	LAB. CONSISTENCY	PENETRATION NO. OF DRIVE IN BLOWS/INCHES	% H ₂ O BY DRY WT.	DRY WT. LB. PER CU. FT.
1-BB	574.4	--	3	12	
2-BB	569.4	--	3	12	
3-BB	564.4	--	1	15	
4-BB	559.4	--	2	15	
5-LB	554.9	Soft	2	12	39.6 81.1
6-LB	549.9	Soft	2	12	36.3 84.9
	544.4	--	2	12	
7-LB	539.9	Soft	2	12	33.1 87.4
	534.4	--	4	12	
8-LB	529.9	V. Soft	4	12	46.6 74.3
	524.4	--	8	12	
	521.9	--	8	12	
9-LB	519.4	--	8	12	
10-LB	514.9	Soft	7	12	30.9 89.9
11-LB	509.9	Soft	6	12	30.8 87.7
12-LB	504.9	Soft	8	12	28.1 93.0
13-LB	499.9	Soft	9	12	26.9 95.5

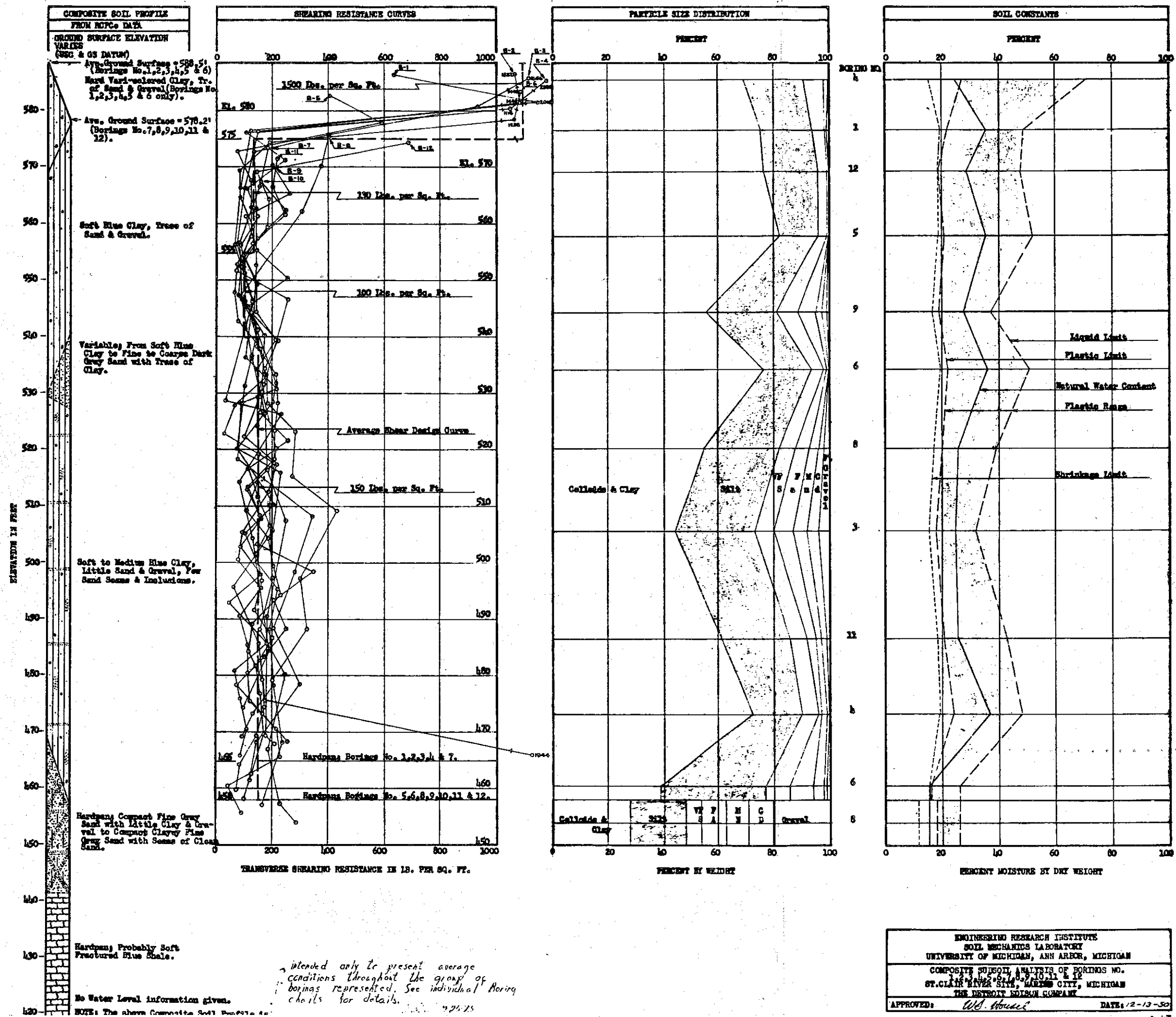
REMARKS: Number of blows required to drive core sampler distance given using a 140-pound weight falling 30 inches.

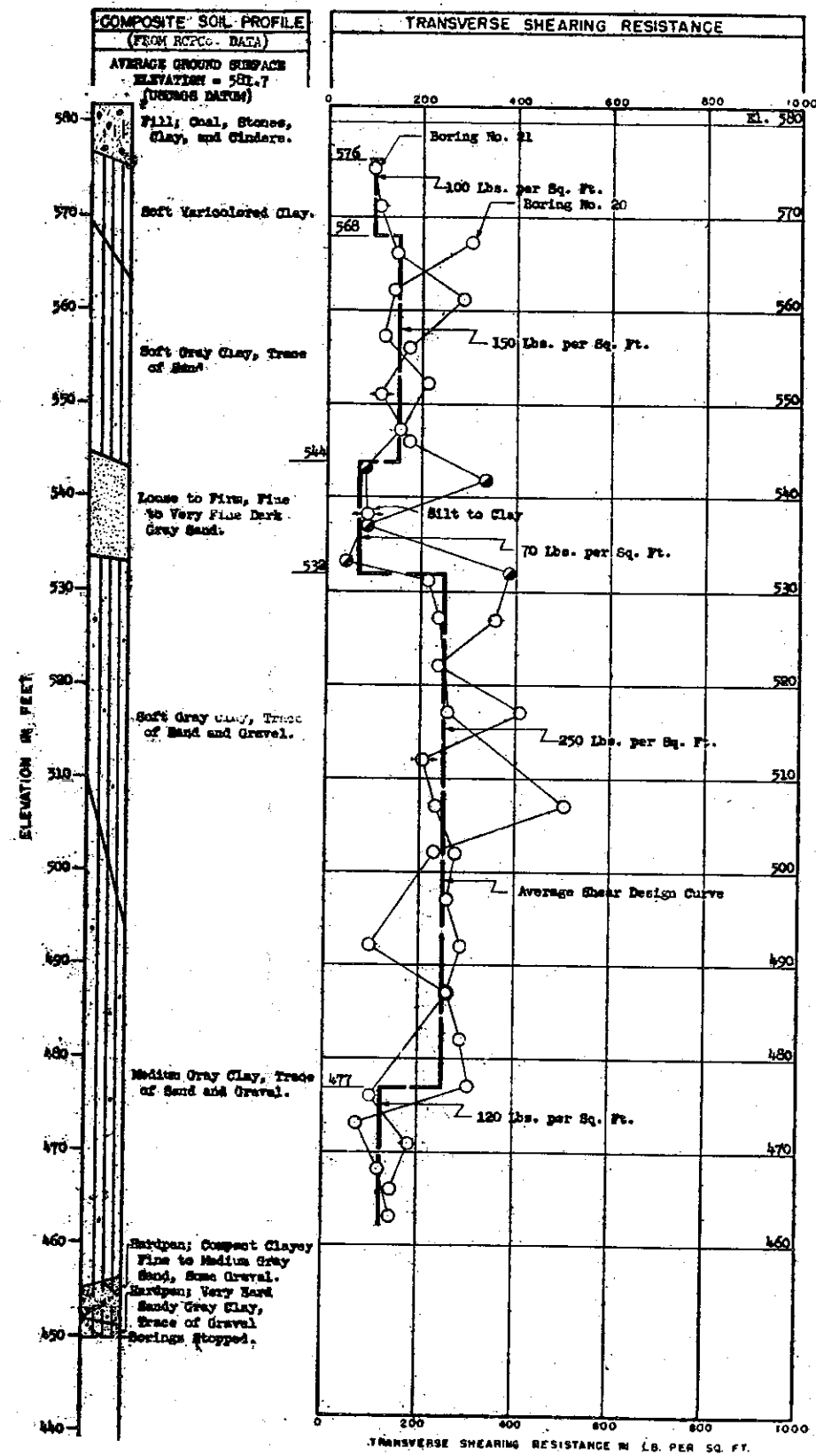


Boring Log and all Sampling by Raymond Concrete Pile Division of Raymond International, Inc.
Boring Job No. RIB-18371-D
Date of Boring: April 12, 1967

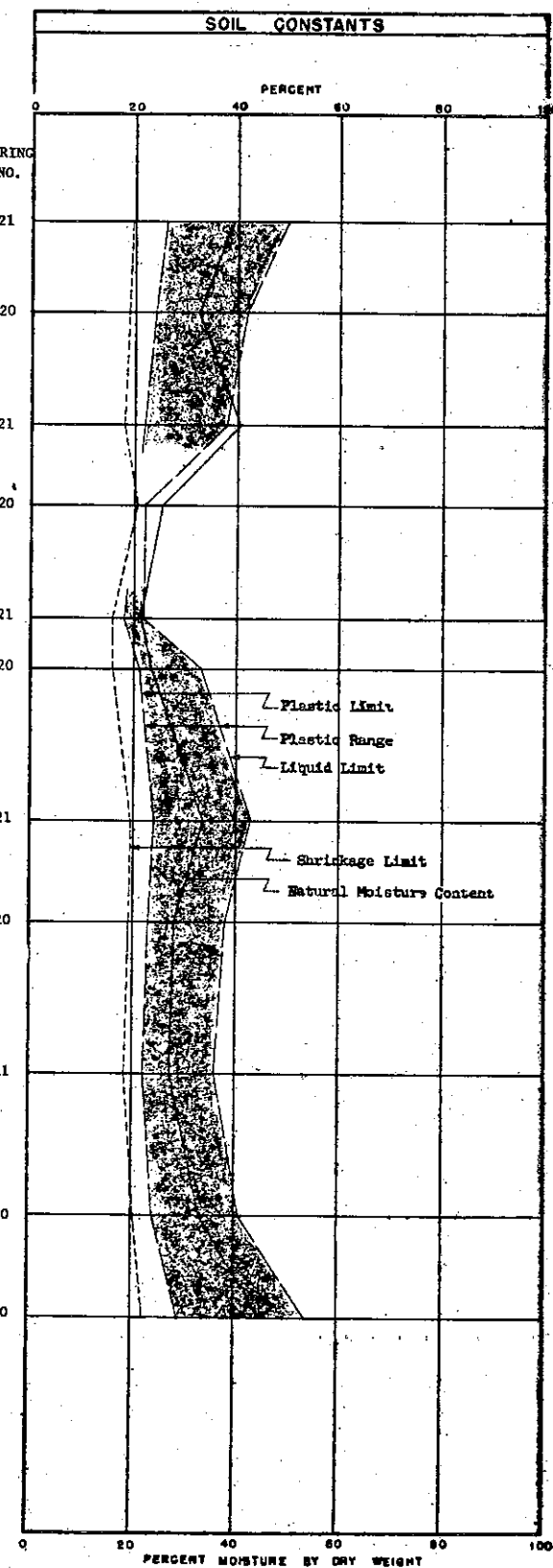
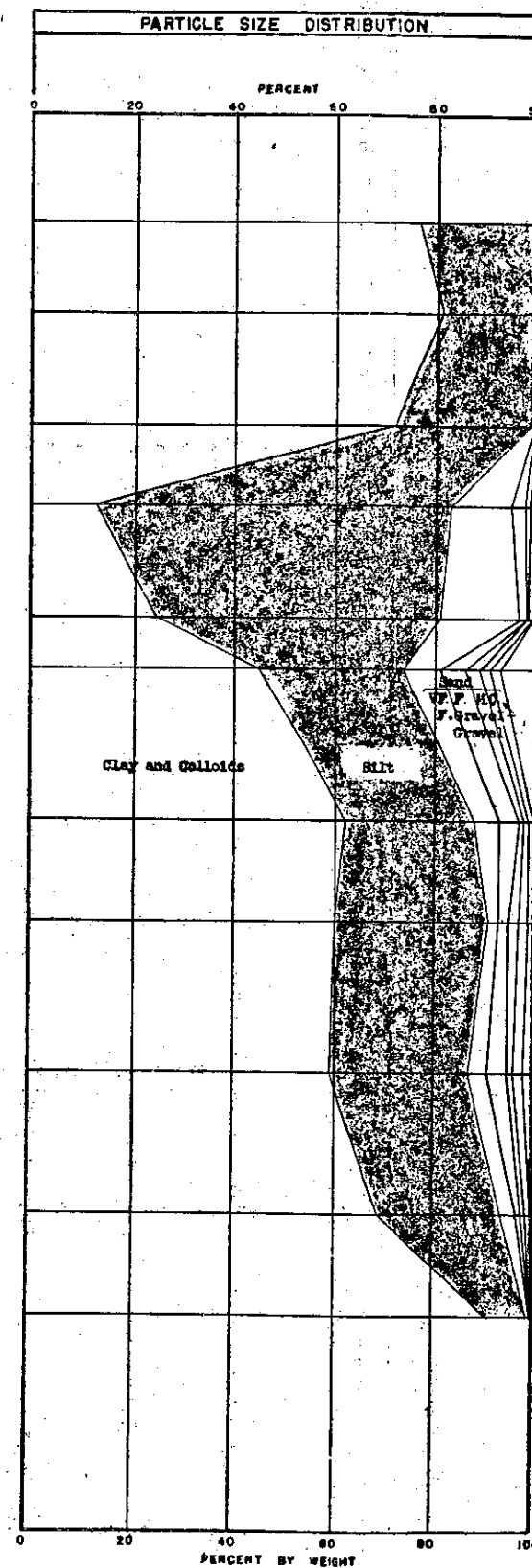
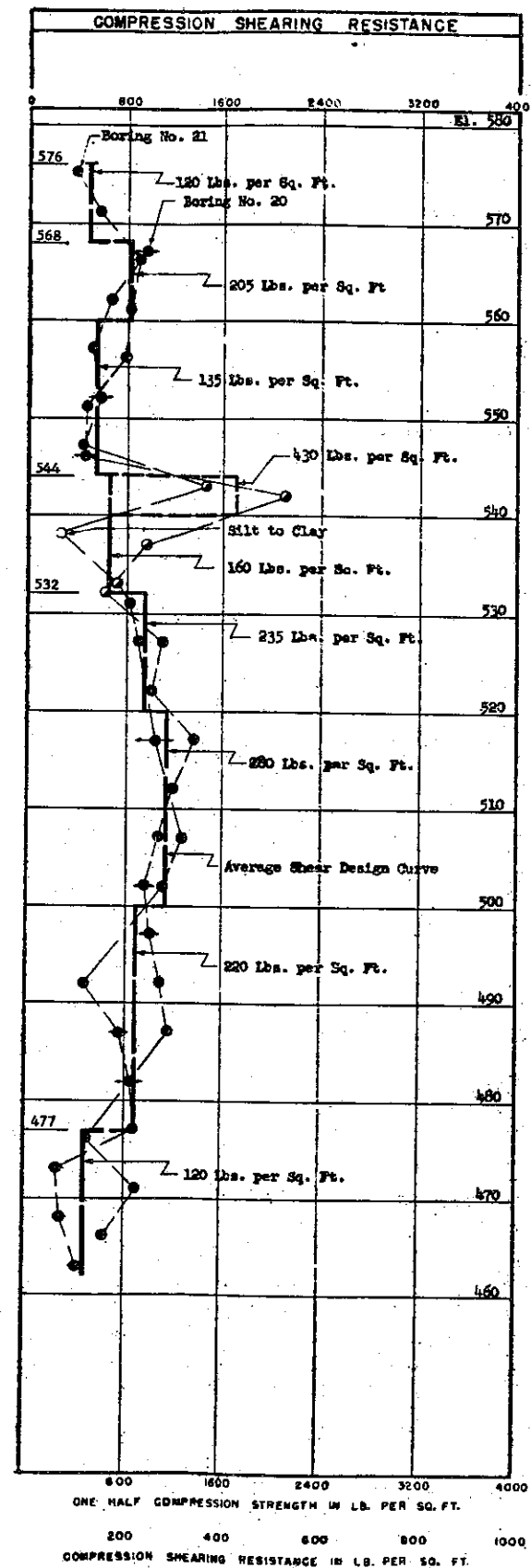
W.L. Water Level at Completion.

ENGINEERING RESEARCH INSTITUTE
SOIL MECHANICS LABORATORY
UNIVERSITY OF MICHIGAN, ANN ARBOR, MICHIGAN
SUBSOIL ANALYSIS OF BORING NO. 35
ST. CLAIR POWER PLANT
THE DETROIT EDISON CO. BELLE RIVER, MICHIGAN
APPROVED: *W.H. Housel* DATE 6-14-67
PROJECT NO. 01994

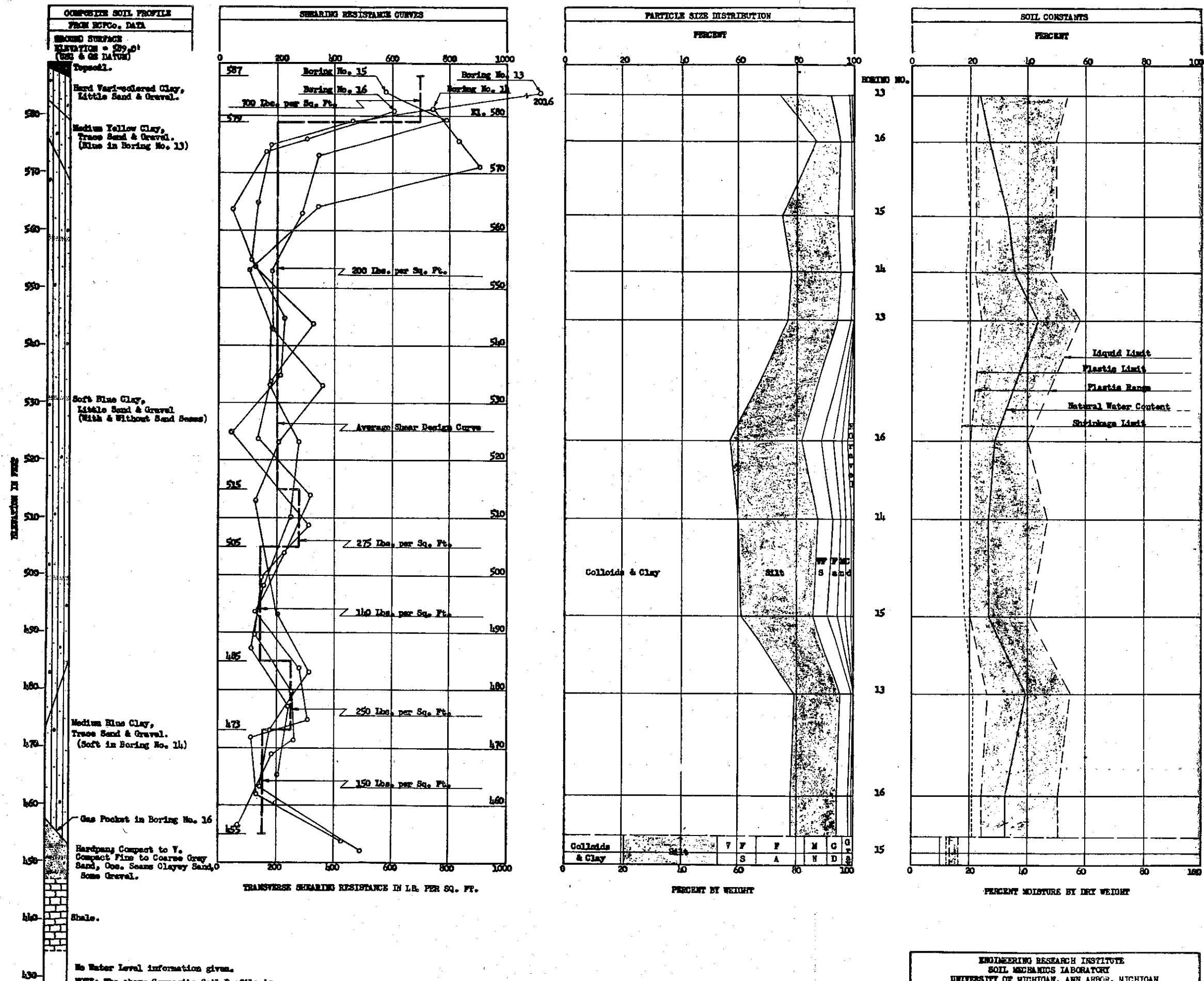


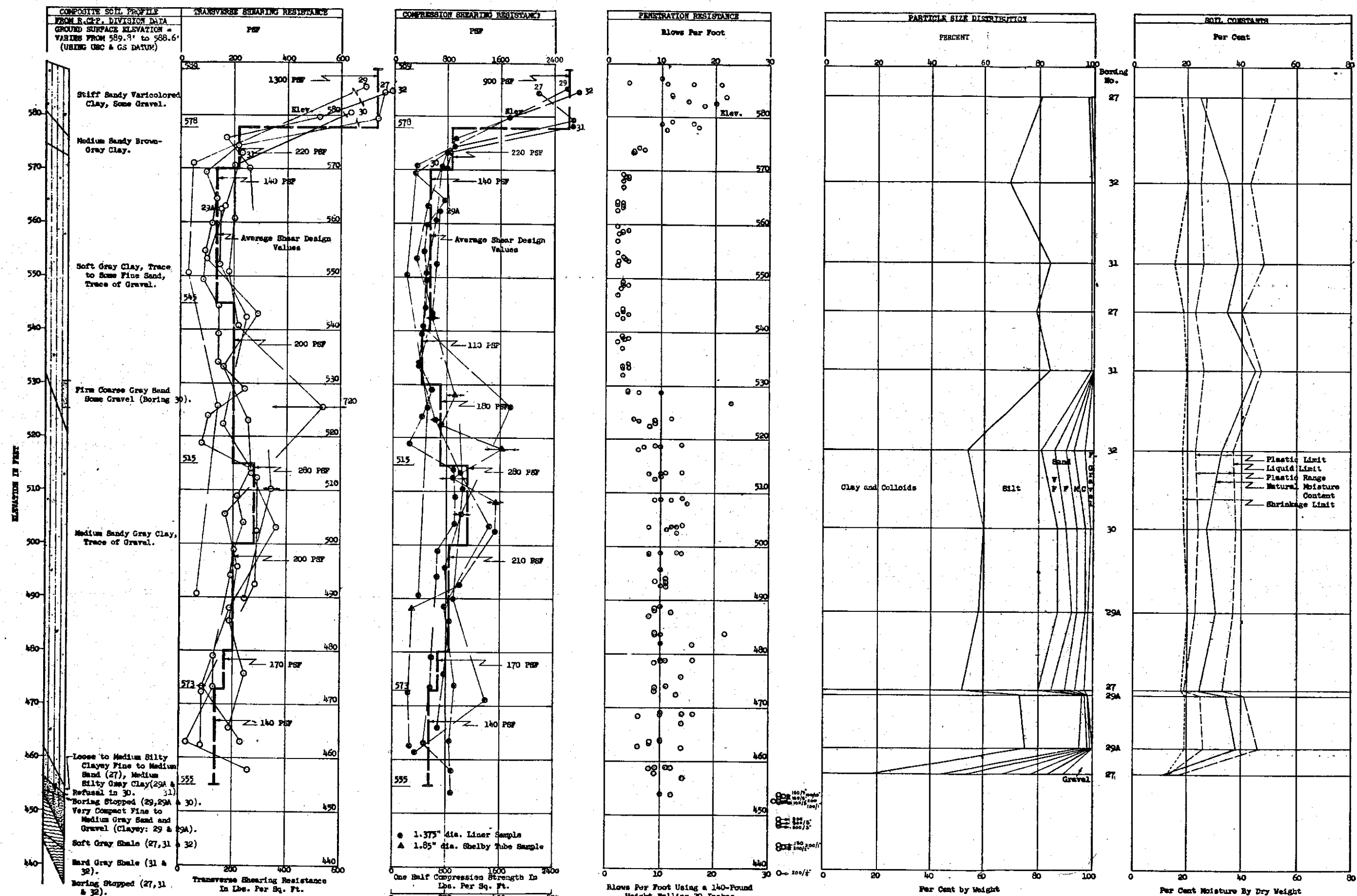


NOTE: The above Composite Soil Profile is intended only to present average conditions throughout the group of borings represented. See individual boring charts for details.



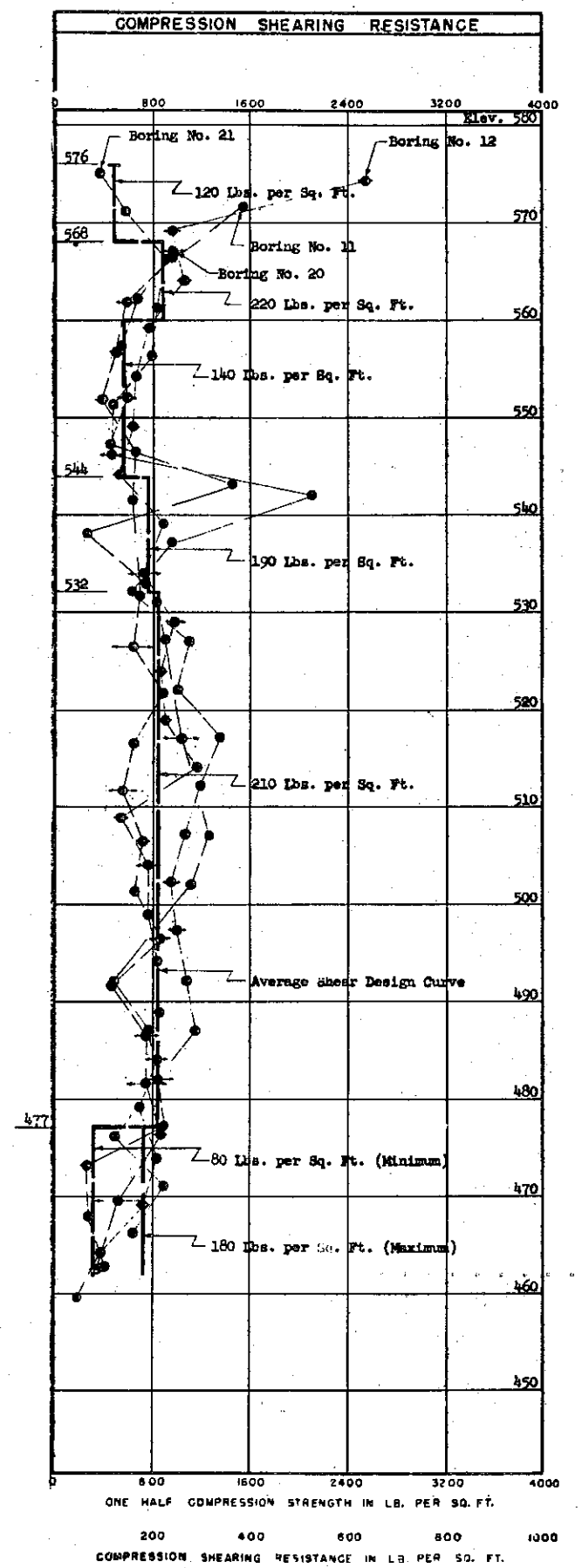
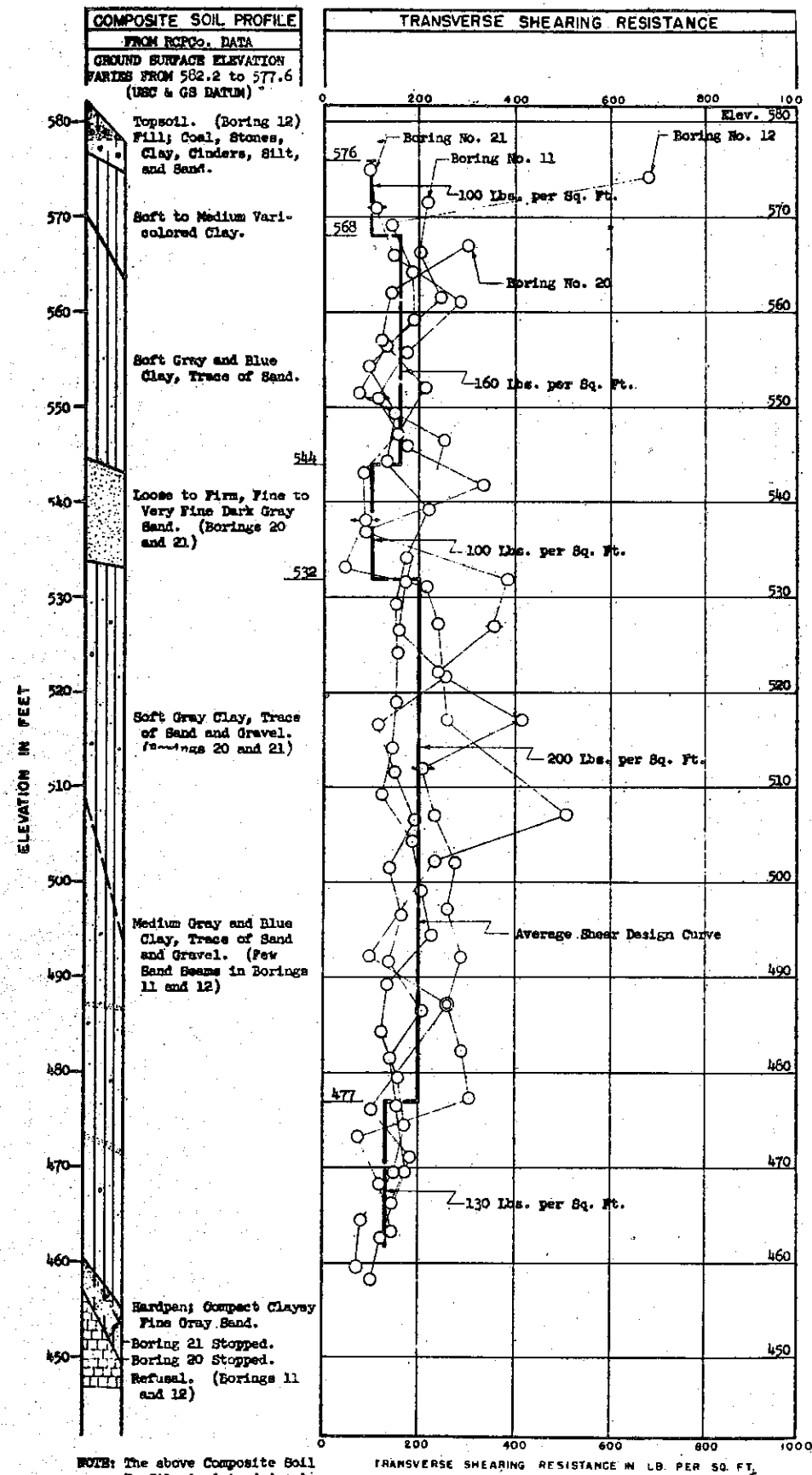
ENGINEERING RESEARCH INSTITUTE
SOIL MECHANICS LABORATORY
UNIVERSITY OF MICHIGAN, ANN ARBOR, MICHIGAN
COMPOSITE SUBSOIL ANALYSIS OF BORINGS NO. 20 and 21
ST. CLAIR POWER PLANT - DETROIT EDISON COMPANY
DETROIT MICHIGAN
APPROVED: *W. H. Hays* DATE: 1-2-59
UNIVERSITY OF MICHIGAN RESEARCH INSTITUTE PROJECT 01994



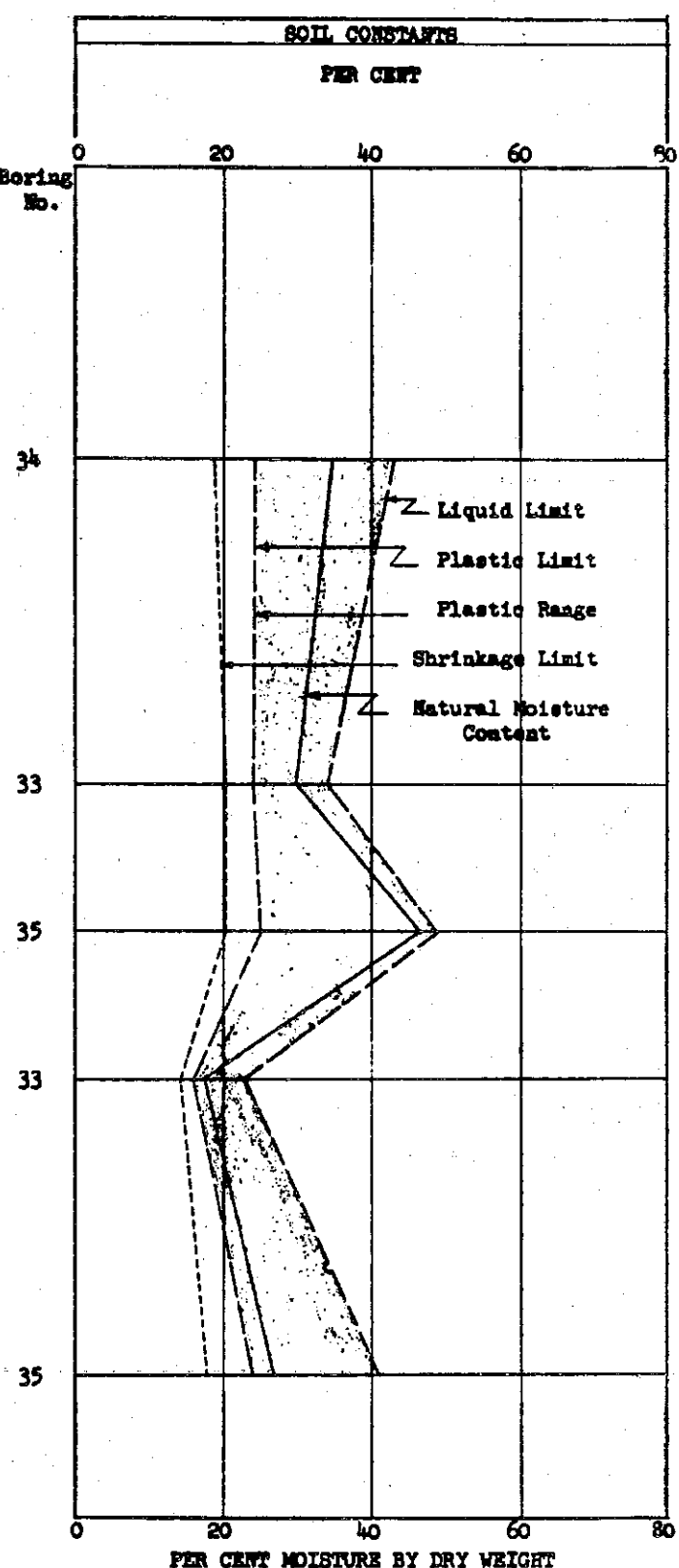
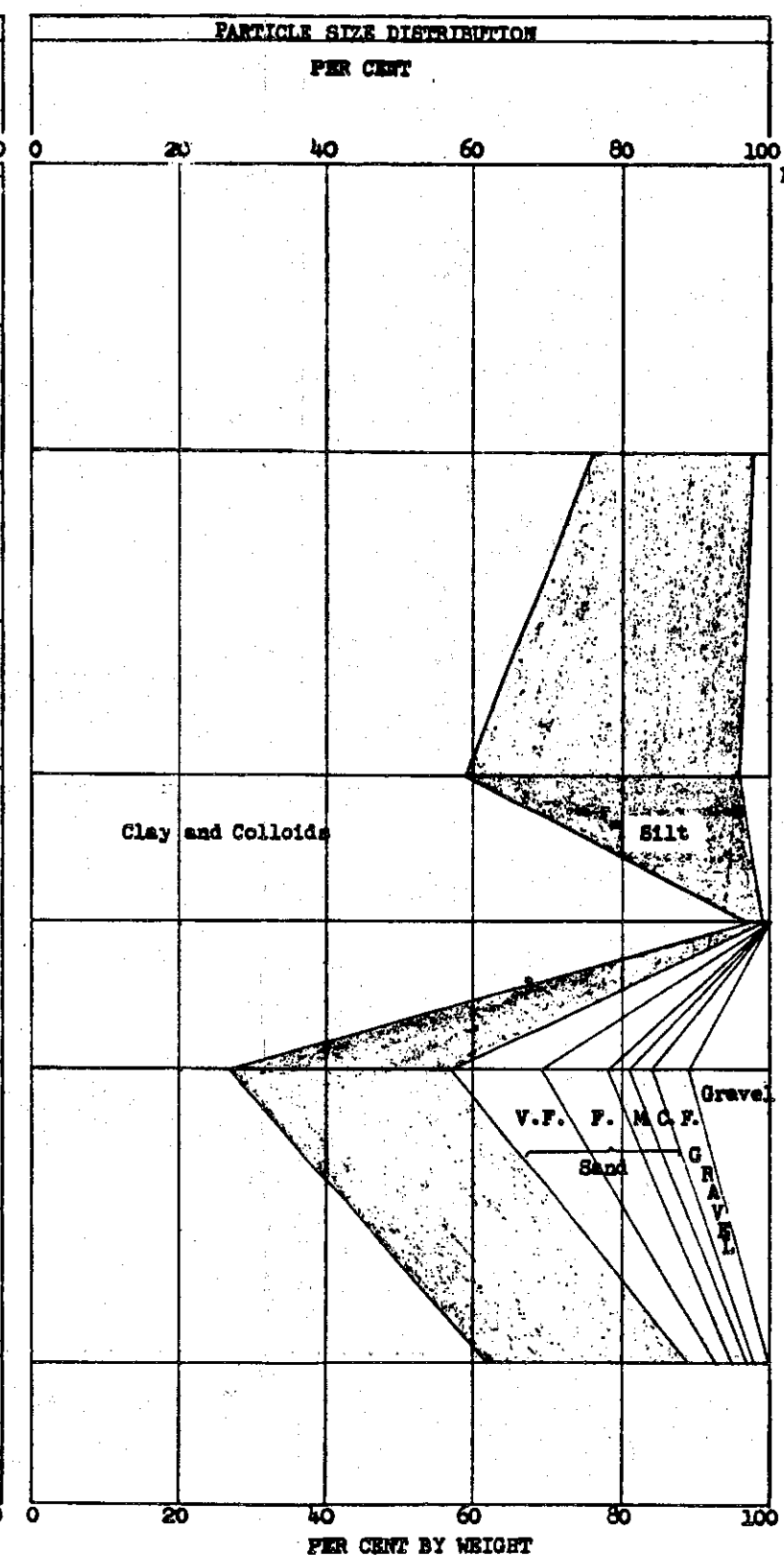
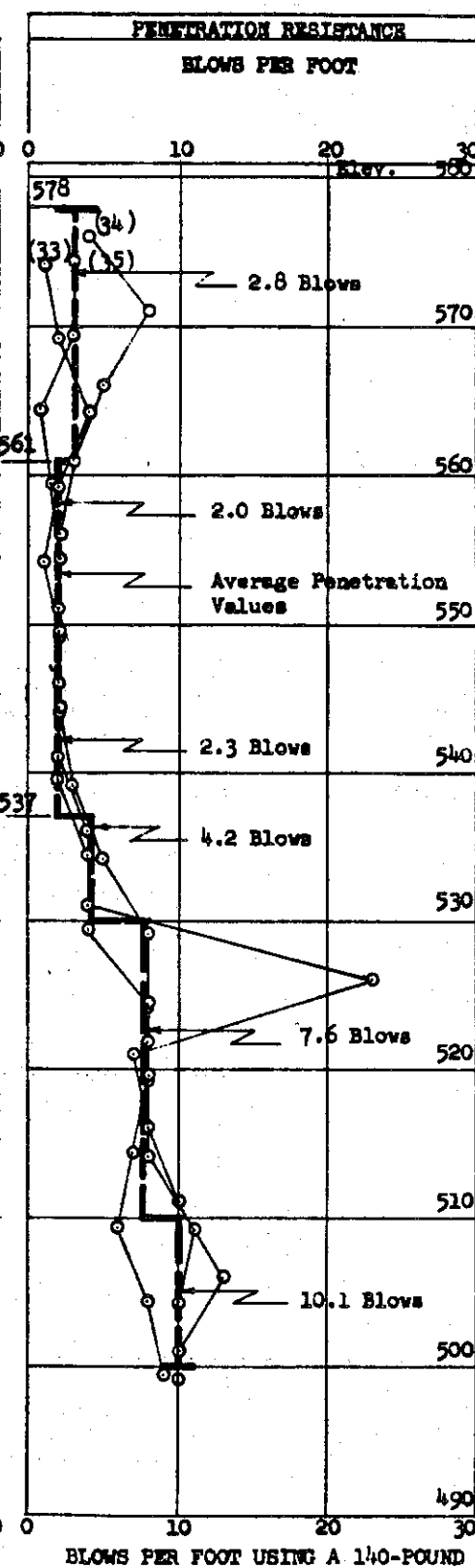
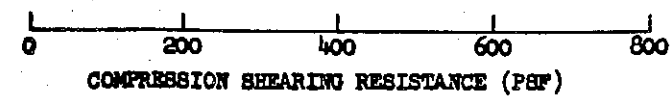
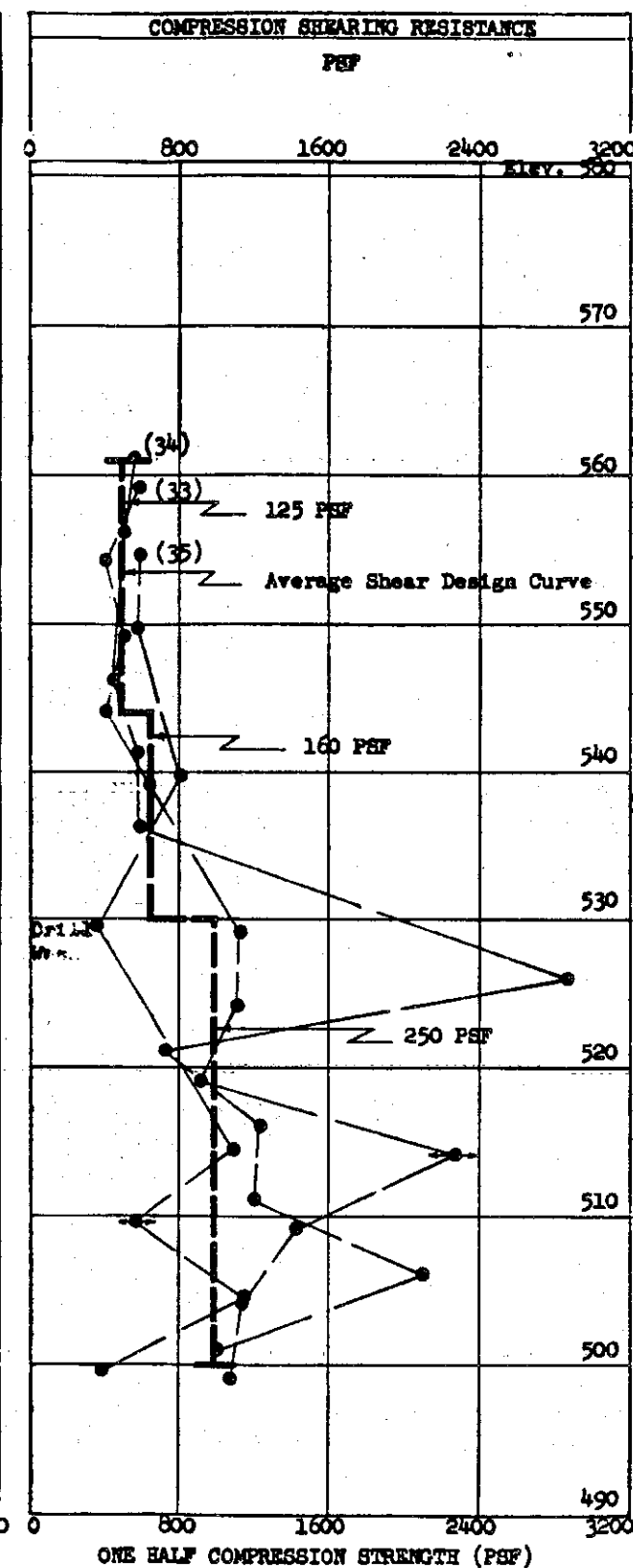
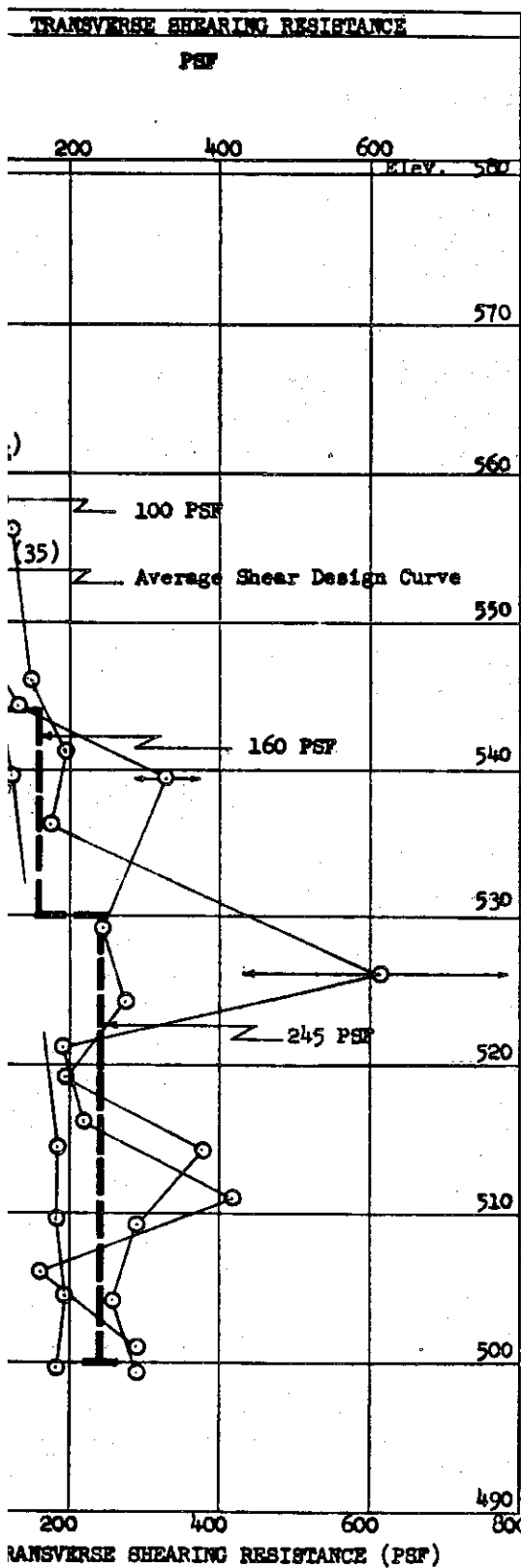


The above Composite Soil Profile is intended only to present average conditions throughout the group of borings represented. See individual Boring Charts for details.
Date of Borings: December 1966 to February 1967

OFFICE OF RESEARCH ADMINISTRATION
SOIL MECHANICS LABORATORY
ANN ARBOR MICHIGAN
COMPOSITE SUBSOIL ANALYSIS OF BORINGS NOS.
27, 29, 29A, 30, 31 AND 32
CAR DUMPER HOUSE - ST. CLAIR POWER PLANT
THE DETROIT EDISON COMPANY ERIE RIVER, MICH.
APPROVED: *[Signature]* DATE: 2-1-67
OFFICE OF RESEARCH ADMINISTRATION PROJECT: 01994



ENGINEERING RESEARCH INSTITUTE
SOIL MECHANICS LABORATORY
UNIVERSITY OF MICHIGAN, ANN ARBOR, MICHIGAN
COMPOSITE SUBSOIL ANALYSIS OF BORINGS NO. 11, 12, 20 AND 21
ST. CLAIR POWER PLANT -- DETROIT EDISON COMPANY
DETROIT MICHIGAN
APPROVED: _____ DATE: _____



OFFICE OF RESEARCH ADMINISTRATION
 SOIL MECHANICS LABORATORY
 UNIVERSITY OF MICHIGAN ANN ARBOR, MICHIGAN
 COMPOSITE SUBSOIL ANALYSIS OF BORINGS NOS. 33, 34 & 35
 ST. CLAIR POWER PLANT
 THE DETROIT EDISON CO. BELLE RIVER, MICHIGAN
 APPROVED: *W. S. Keller* DATE: 6-14-54
 PROJECT NO. 01994

TABLE OF DRILL HOLES

Hole No	Location	Surface Elevation	Depth(ft)	Purpose	Type Drilling	Number and Type		Ground Water	
						U.D.	Samples Taken	Level ¹	Date
7	N 7,507 E 7,851	586.6	143.0	Observation Well	Rotary Wash, Standard Pen ASTM	None	None	10.0	4-25-74
8	N 7,495 E 8,304	586.5	165.1	Original Proposed Plant Area	Rotary Wash, Standard Pen ASTM, NX Core	None	None		
9	N 8,576 E 9,361	586.7	144.0	Proposed Plant Area	Rotary Wash, Standard Pen ASTM	None	None		
10	N 8,600 E 9,965	586.1	155.5	Proposed Plant Area	Rotary Wash, Standard Pen ASTM, NX Core	None	None		
11	N 8,316 E 8,715	586.7	150.0	Proposed Plant Area	Rotary Wash, Standard Pen ASTM	None	None		
12	N 7,884 E 9,005	586.8	174.2	Proposed Plant Area	Rotary Wash, Standard Pen ASTM, NX Core	Shelby 9	Shelby 9		
13	N 8,321 E 9,336	586.5	144.0	Proposed Plant Area	Rotary Wash, Standard Pen ASTM	None	None		
14	N 8,306 E 9,627	586.6	145.0	Proposed Plant Area	Rotary Wash, Standard Pen ASTM, Shelby, Osterberg	Shelby 11 Osterberg 3	Shelby 11 Osterberg 3		
15	N 8,320 E 9,786	586.2	142.0	Proposed Plant Area	Rotary Wash, Standard Pen ASTM, Shelby, Osterberg	Shelby 6 Osterberg 6	Shelby 6 Osterberg 6		
16	N 7,996 E 8,712	586.0	143.8	Proposed Plant Area	Rotary Wash, Standard Pen ASTM	None	None		
17	N 8,000 E 9,004	585.9	183.3	Proposed Plant Area	Rotary Wash, Standard Pen ASTM, Shelby, NX Core	Shelby 6	Shelby 6		

NOTE: Borings 1-6 not drilled.

Hole No	Location	Depth(ft)	Surface Elevation	Purpose	Type Drilling	Number and Type		Ground Water	
						U.D.	Samples Taken	Level ¹	Depth(ft) Date
27	N 7,719 E 9,205	187.5	586.2	Proposed Plant Area	Rotary Wash, Standard Pen ASTM, Shelby, NX Core		Shelby 15		
28	N 7,724 E 9,443	193.5	585.8	Proposed Plant Area	Rotary Wash, Standard Pen ASTM, Shelby, NX Core		Shelby 10		
29	N 7,685 E 8,724	169.0	585.8	Proposed Plant Area	Rotary Wash, Standard Pen ASTM, NX Core	None			
30	N 7,673 E 9,015	135.0	586.4	Proposed Plant Area	Rotary Wash, Standard Pen ASTM	None			
31	N 7,669 E 9,331	143.4	585.9	Proposed Plant Area	Rotary Wash, Standard Pen ASTM	None			
32	N 7,663 E 9,659	144.5	586.6	Proposed Plant Area	Rotary Wash, Standard Pen ASTM	None			
33	N 7,400 E 9,322	138.5	585.6	Proposed Plant Area	Rotary Wash, Standard Pen ASTM, Shelby		Shelby 13		
34	N 7,398 E 9,963	158.17	586.0	Proposed Plant Area	Rotary Wash, Standard Pen ASTM, NX Core	None			
37	N 9,006 E 11,987	133.0	588.0	Original Proposed Coal Storage Area	Rotary Wash, Standard Pen ASTM	None			
38	N 9,007 E 13,035	153.0	598.3	Original Proposed Coal Storage Area	Rotary Wash, Standard Pen ASTM, Shelby, NX Core		Shelby 11		

NOTE: Borings 35&36 not drilled.

Hole No	Location	Depth(ft)	Surface Elevation	Purpose	Type Drilling	Number and Type		Ground Water	
						U.D.	Samples Taken	Level	Depth(ft) Date
49	N 3,695 E 12,440	155.0	586.6	Proposed Conveyor System	Rotary Wash, Standard Pen ASTM, Shelby, NX Core		Shelby 15		
50	N 2,951 E 15,471	153.75	581.8	Proposed Dock Area	Rotary Wash, Standard Pen ASTM, Shelby, NX Core		Shelby 10		
52	N 2,375 E 15,271	158.5	582.1	Proposed Dock Area	Rotary Wash, Standard Pen ASTM, Shelby, Osterberg, NX Core		Shelby 2 Osterberg 11		
53	N 2,052 E 15,176	154.91	580.6	Proposed Dock Area	Rotary Wash, Standard Pen ASTM, Shelby, Osterberg, NX Core		Shelby 8 Osterberg 5		
54	N 2,937 E 15,537	147.67	541.6	Proposed Dock Area	Rotary Wash, Standard Pen ASTM, Shelby, Osterberg, NX Core		Shelby 17 Osterberg 2		
55	N 2,645 E 15,506	100.0	547.9	Proposed Dock Area	Rotary Wash, Standard Pen ASTM		None		
56	N 2,296 E 15,399	102.0	547.5	Proposed Dock Area	Rotary Wash, Standard Pen ASTM		None		
57	N 1,907 E 15,247	120.2	548.3	Proposed Dock Area	Rotary Wash, Standard Pen ASTM, Osterberg, NX Core		Osterberg 1		
58	N 2,725 E 15,224	162.0	583.5	Proposed Dock Area	Rotary Wash, Standard Pen ASTM, NX Core		None		

NOTE: Boring 51 not drilled.

Hole No	Location	Depth(ft)	Surface Elevation	Purpose	Type Drilling	Number and Type		Ground Water Level ¹
						U.D.	Samples Taken	
								Depth(ft) Date
105	N 4,979 E 10,998	160.3	588.3	Proposed Coal Storage Area	Rotary Wash, Standard Pen ASTM, Shelby, Pitcher, Osterberg, NX Core	Shelby 4 Pitcher 2 Osterberg 6		
106	N 4,836 E 12,528	140.0	589.7	Proposed Coal Storage Area	Rotary Wash, Standard Pen ASTM	None		
109	N 6,450 E 13,140	142.7	600.7	Proposed Coal Storage Area	Rotary Wash, Standard Pen ASTM	None		
110	N 6,570 E 12,830	146.3	599.8	Proposed Coal Storage Area	Rotary Wash, Standard Pen ASTM, Shelby, Osterberg	Shelby 12 Osterberg 5		
111	N 6,600 E 11,000	140.0	588.5	Original Proposed Coal Storage Area	Rotary Wash, Standard Pen ASTM	None		
112	N 6,824 E 8,900	160.5	587.0	Original Proposed Switchyard	Rotary Wash, Standard Pen ASTM, Shelby, NX Core	Shelby 3		
113	N 6,800 E 9,360	164.3	587.4	Proposed Switchyard	Rotary Wash, Standard Pen ASTM, Shelby, NX Core	Shelby 3		
114	N 6,980 E 13,360	144.2	599.5	Proposed Coal Storage Area	Rotary Wash, Standard Pen ASTM	None		
115	N 7,100 E 13,060	144.0	600.7	Proposed Coal Storage Area	Rotary Wash, Standard Pen ASTM, Shelby	Shelby 14		
116	N 7275.71 E 8897.94	180.5	585.6	Benchmark	Rotary Wash, Standard Pen ASTM, Shelby, NX Core	Shelby 14		

NOTE: Borings 107&108 not drilled.

Hole No	Location	Depth(ft)	Surface Elevation	Purpose	Type Drilling	Number and Type		Ground Water Level
						U.D.	Samples Taken	Depth(ft) Date
128	N 3,000 E 11,000	141.5	589.5	Proposed Coal Storage Area	Rotary Wash, Standard Pen ASTM	None		
129	N 3,000 E 12,000	158.8	586.0	Proposed Coal Storage Area	Rotary Wash, Standard Pen ASTM, Pitcher, Osterberg, NX Core	Pitcher 9 Osterberg 3		
130	N 9,014 E 4,993	145.0	595.3	Proposed Ash Disposal Area	Rotary Wash, Standard Pen ASTM	None		
131	N 9,400 E 6,000	105.0	589.9	Proposed Ash Disposal Area	Rotary Wash, Standard Pen ASTM	None		
134	N 10,050 E 4,995	128.5	594.6	Proposed Ash Disposal Area	Rotary Wash, Standard Pen ASTM	None		
135	N 10,050 E 6,000	70.0	591.3	Proposed Ash Disposal Area	Rotary Wash, Standard Pen ASTM	None		
136	N 10,050 E 7,000	130.0	590.2	Proposed Ash Disposal Area	Rotary Wash, Standard Pen ASTM, Shelby	Shelby 3		
137	N 10,050 E 8,000	71.0	588.9	Proposed Ash Disposal Area	Rotary Wash, Standard Pen ASTM	None		
138	N 10,030 E 8,977	145.0	588.7	Proposed Ash Disposal Area	Rotary Wash, Standard Pen ASTM	None		
139	N 10,866 E 4,990	145.5	595.7	Proposed Ash Disposal Area	Rotary Wash, Standard Pen ASTM	None		
140	N 10,850 E 6,003	70.5	592.0	Proposed Ash Disposal Area	Rotary Wash, Standard Pen ASTM	None		

NOTE: Børings 132&133 not drilled.

Hole No	Location	Depth(ft)	Surface Elevation	Purpose	Type Drilling	Number and Type		Ground Water	
						U.D.	Samples Taken	Level	Depth(ft) Date
154	N 13,785 E 8,000	165.0	599.0	Proposed Ash Disposal Area	Rotary Wash, Standard Pen ASTM	None			
155	N 14,001 E 5,996	70.0	601.4	Proposed Ash Disposal Area	Rotary Wash, Standard Pen ASTM	None			
157	N 14,000 E 8,000	70.0	591.5	Proposed Ash Disposal Area	Rotary Wash, Standard Pen ASTM	None			
158	N 14,000 E 9,000	130.0	589.6	Proposed Ash Disposal Area	Rotary Wash, Standard Pen ASTM, Shelby	Shelby 4			
159	N 14,000 E 9,950	70.0	591.3	Proposed Ash Disposal Area	Rotary Wash, Standard Pen ASTM	None			
160	N 14,522 E 4,880	159.0	595.5	Proposed Ash Disposal Area	Rotary Wash, Standard Pen ASTM	None			
163	N 15,000 E 8,000	138.0	591.4	Proposed Ash Disposal Area	Rotary Wash, Standard Pen ASTM	None			
164	N 15,000 E 9,000	70.0	591.4	Proposed Ash Disposal Area	Rotary Wash, Standard Pen ASTM	None			
165	N 14,830 E 9,938	156.5	594.3	Proposed Ash Disposal Area	Rotary Wash, Standard Pen ASTM	None			
180	N 2,925 E 12,180	140.0	588.0	Proposed Coal Storage Area	Rotary Wash, Standard Pen ASTM	None			
181	N 3,525 E 12,533	144.0	590.8	Observation Well	Rotary Wash, Standard Pen ASTM	None		10.0	4-25-74

NOTE: Borings 152,153,156,161,162 and 165-179 not drilled.

CONSISTENCY OF COHESIVE & SEMI-COHESIVE SOILS

- V. Soft Almost completely lacks resistance to external forces causing deformation. Will slump or deform of its own weight. When squeezed in fist, it will ribbon or ooze out between fingers. Sometimes referred to as "toothpaste" consistency. Moisture content near or above liquid limit (wet).
- Soft Only slightly resistant to external forces causing deformation. Will support its own weight. When squeezed in fist, impression of fingers is marked and soil will squeeze between fingers. Can be molded to any shape without resistance. Moisture content well above plastic limit (very moist).
- Medium May be deformed readily without rupture.
(Plastic) When squeezed in fist, impression by fingers will be pronounced but it will not squeeze. Can be molded to any shape, but offers some resistance--will probably "check" or crack slightly. Moisture content slightly above plastic limit (moist).
- Firm Moderately resistant to external forces causing rupture. Lumps or cores can be broken by fingers. When squeezed in fist, impression by fingers is slight. No tendency to squeeze. Will rupture and lose structure if molding is attempted from original shape. Once structure is lost, however, it can be molded or "packed." Moisture content near the plastic limit (damp to moist).
- Stiff Resistant to external forces causing deformation. Lumps or cores can be broken by fingers. When squeezed in fist, or pressed by thumb, indentation by fingers is only slight regardless of pressure applied. Cannot be molded from original shape. Moisture content near the shrinkage limit (damp).
- Hard Very resistant to external forces causing deformation. Lumps or cores can be broken by fingers, but with difficulty. Cannot be indented by fingers or thumb, but can be scored readily by fingernail. Moisture content below the shrinkage limit (dry).
- V. Hard Extremely resistant to external forces causing deformation. Lumps or cores cannot be broken by fingers. Cannot be indented by fingers or thumb; can be scored only slightly by fingernail. Moisture content below the shrinkage limit (dry).

CONSISTENCY OF GRANULAR SOILS (by standard penetration index)

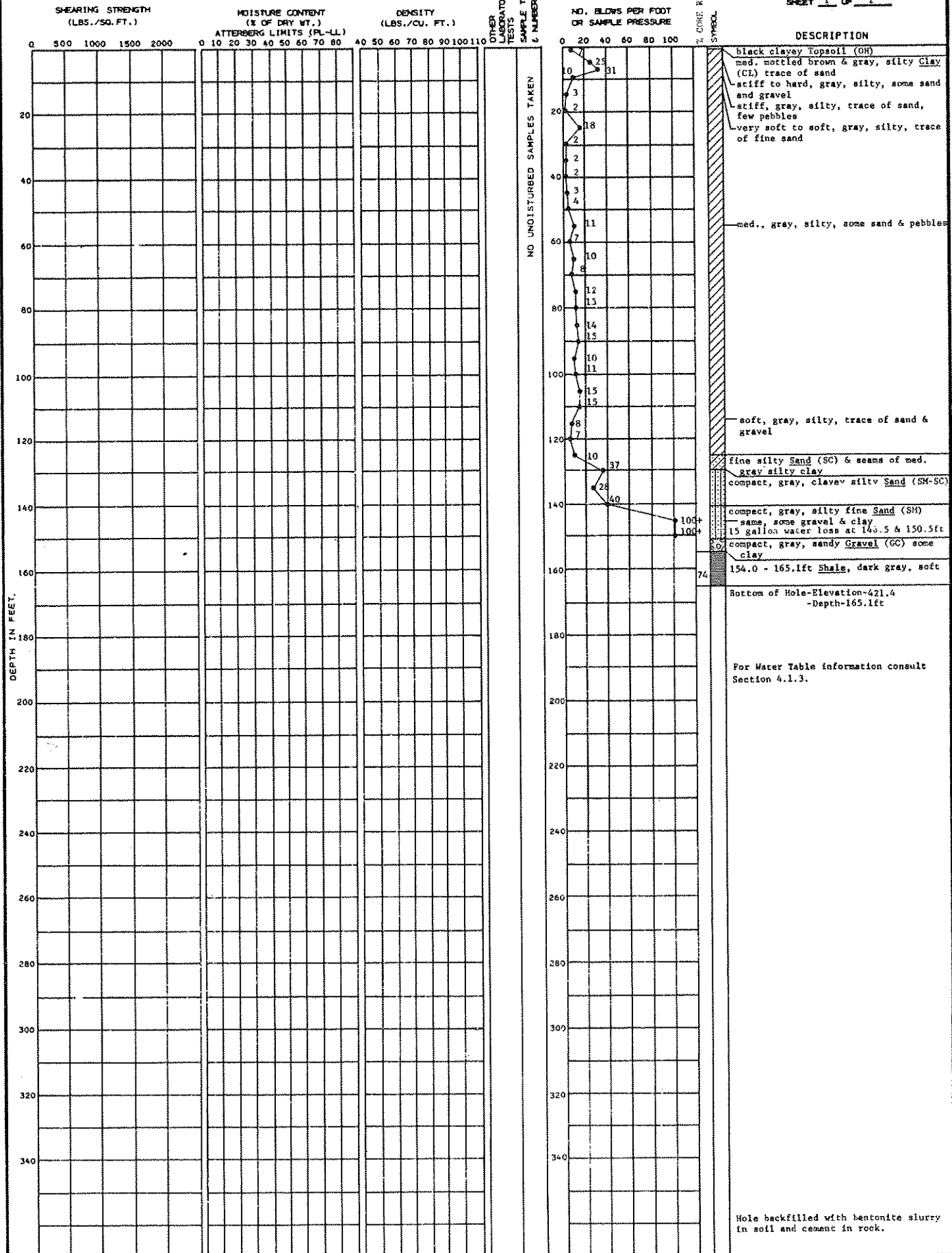
V. Loose	--- 0-4 blows
Loose	--- 5-10 blows
Medium Compact	--- 11-25 blows
Compact	--- 26-50 blows
V. Compact	--- 50+ blows

LOCATION: N 7,495
E 8,304

GROUND ELEVATION 586.5

DATE DRILLED: 11-26-73
12-3-73

SHEET 1 OF 1



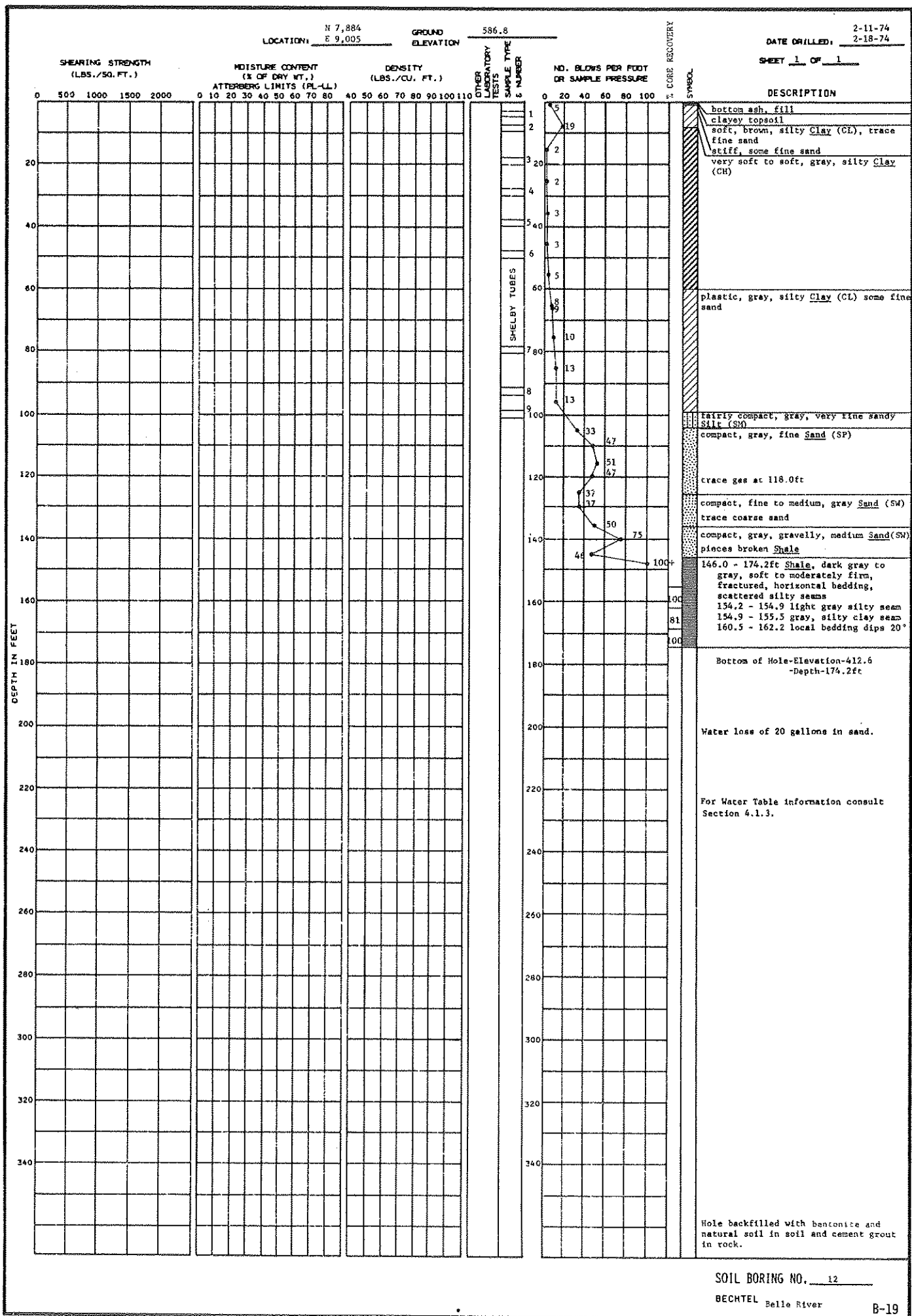
SOIL BORING NO. 8

BECHTEL Belle River

B-15

DESCRIPTION



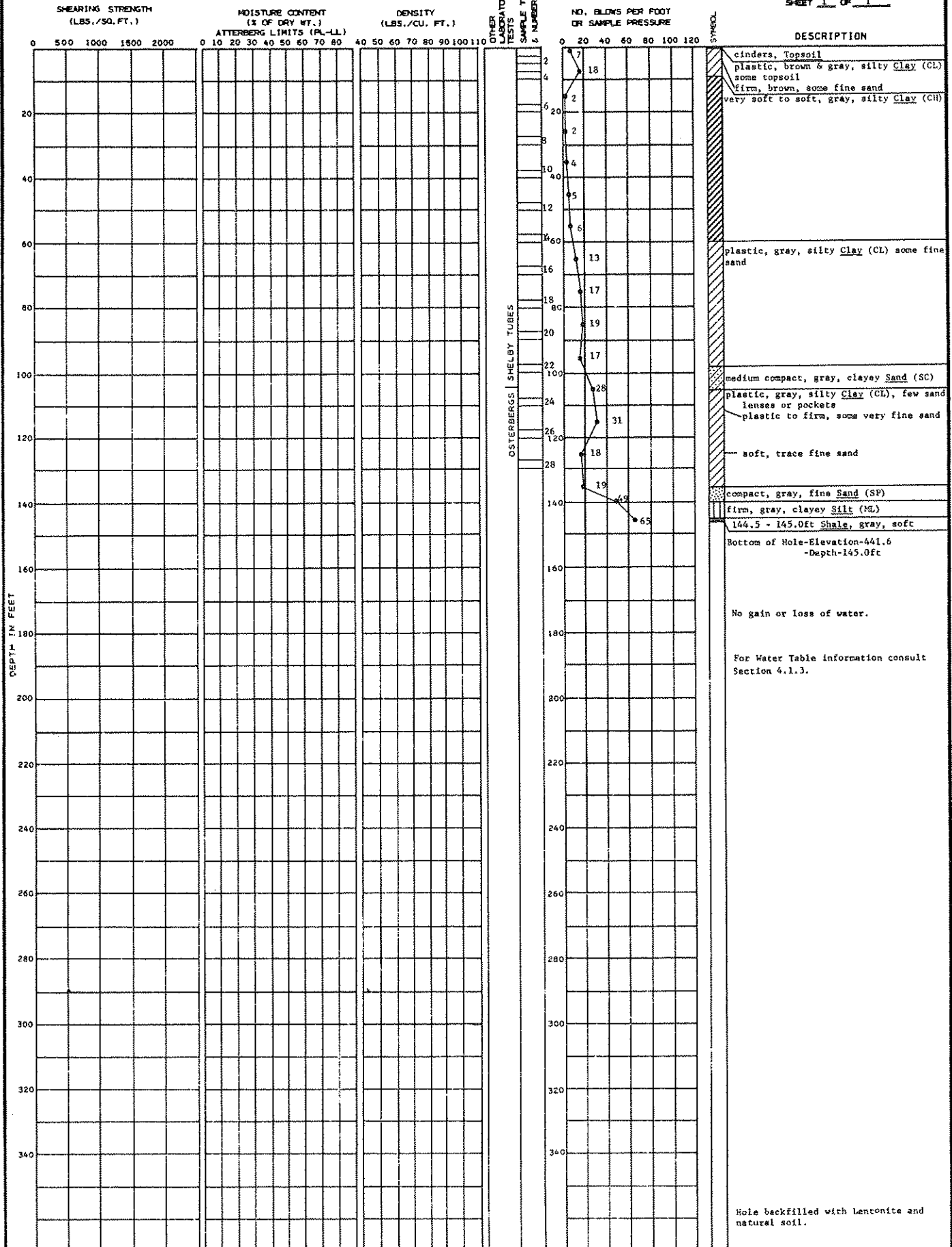


LOCATION: N 8,306
E 9,627GROUND
ELEVATION

586.6

DATE DRILLED: 1-28-74
1-31-74

SHEET 1 OF 1



SOIL BORING NO. 14

BECHTEL Belle River

B-21

LOCATION: N 7,996
E 8,712

GROUND
ELEVATION

586.0

DATE DRILLED: 2-12-74
2-14-74

SHEET 1 OF 1

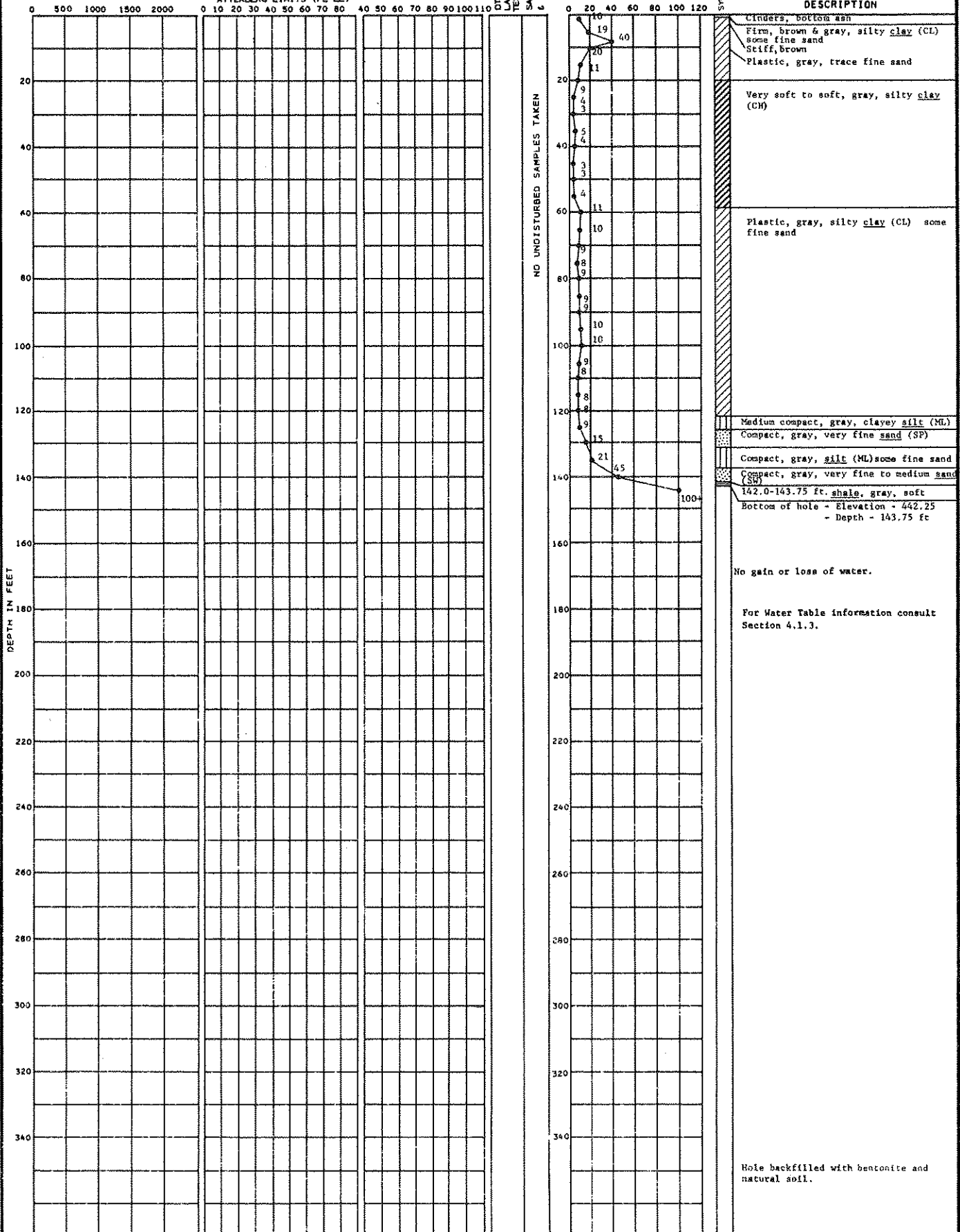
SHEARING STRENGTH
(LBS./SQ. FT.)

MOISTURE CONTENT
(% OF DRY WT.)
ATTERBERG LIMITS (PL-LL)

DENSITY
(LBS./CU. FT.)

NO. BLOWS PER FOOT
OR SAMPLE PRESSURE

DESCRIPTION



SOIL BORING NO. 16

BECHTEL Belle River

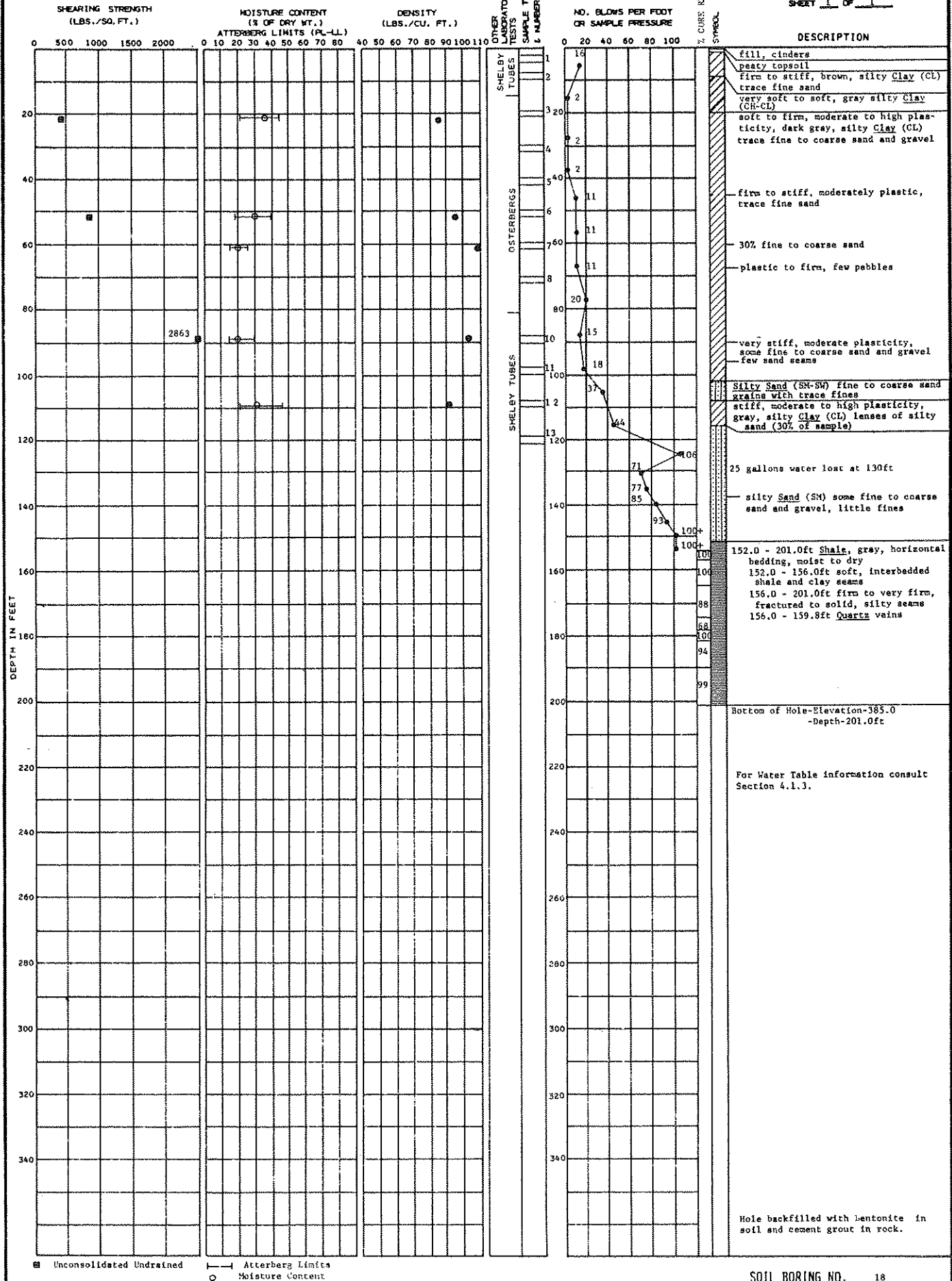
B-23

LOCATION: N 8,081
E 9,193GROUND
ELEVATION

586.0

DATE DRILLED: 1-16-74
1-29-74

SHEET 1 OF 1

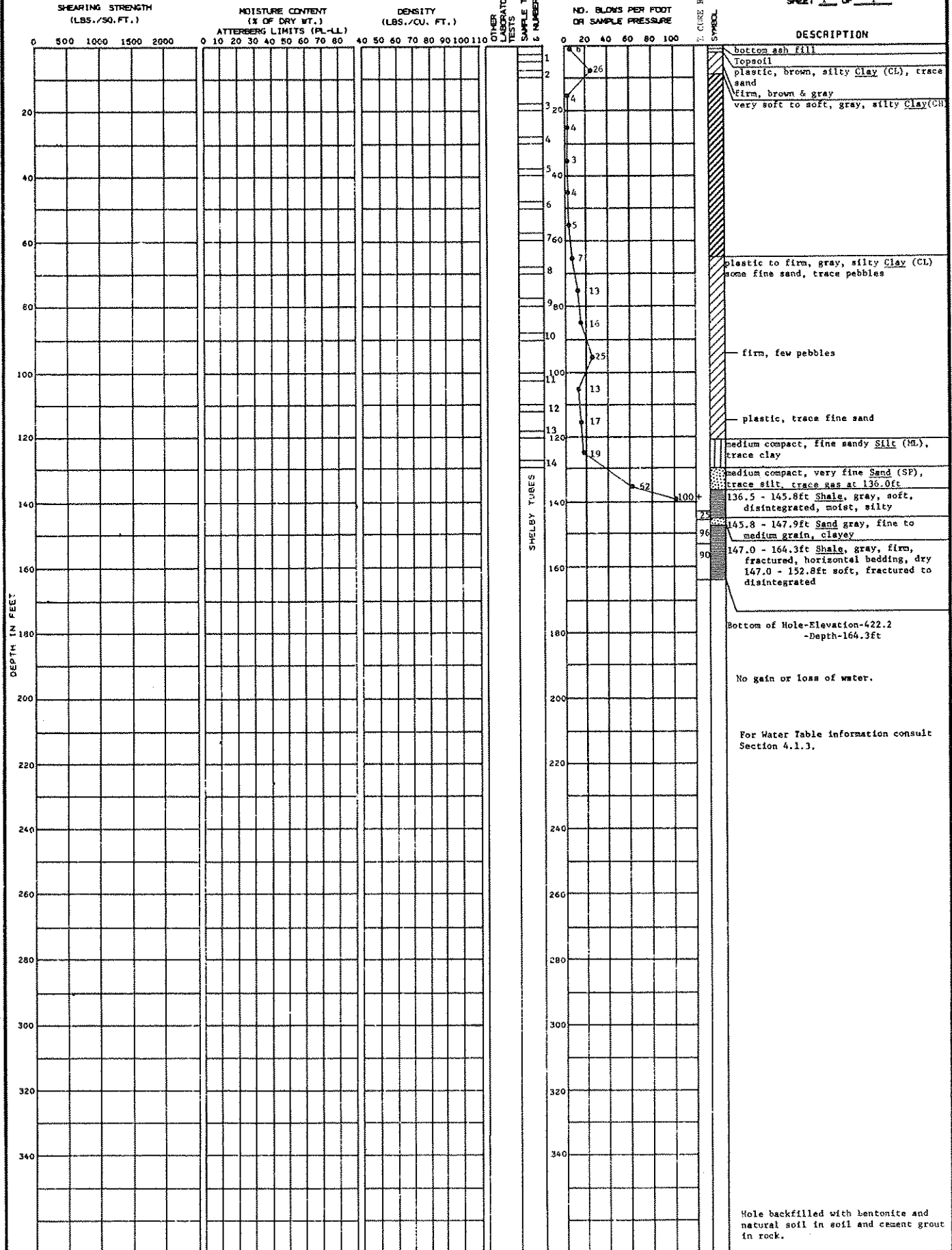


LOCATION: N 8,011
E 9,337

GROUND ELEVATION 586.5

DATE DRILLED: 1-17-74
1-23-74

SHEET 1 OF 1



SOIL BORING NO. 20

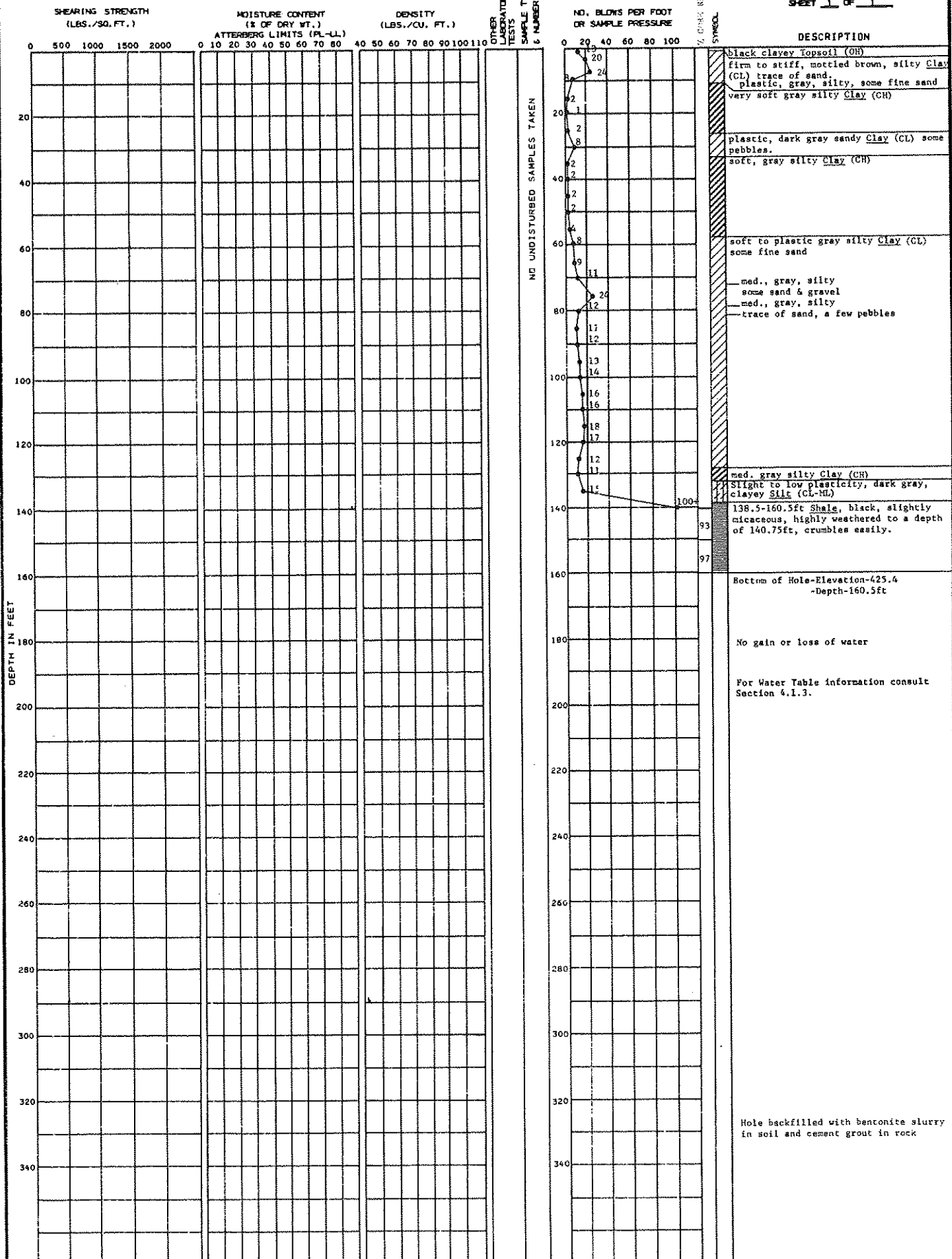
BECHTEL Belle River

LOCATION: N.8,002
E.9,943GROUND
ELEVATION

585.9

DATE DRILLED: 11-20-73

SHEET 1 OF 1

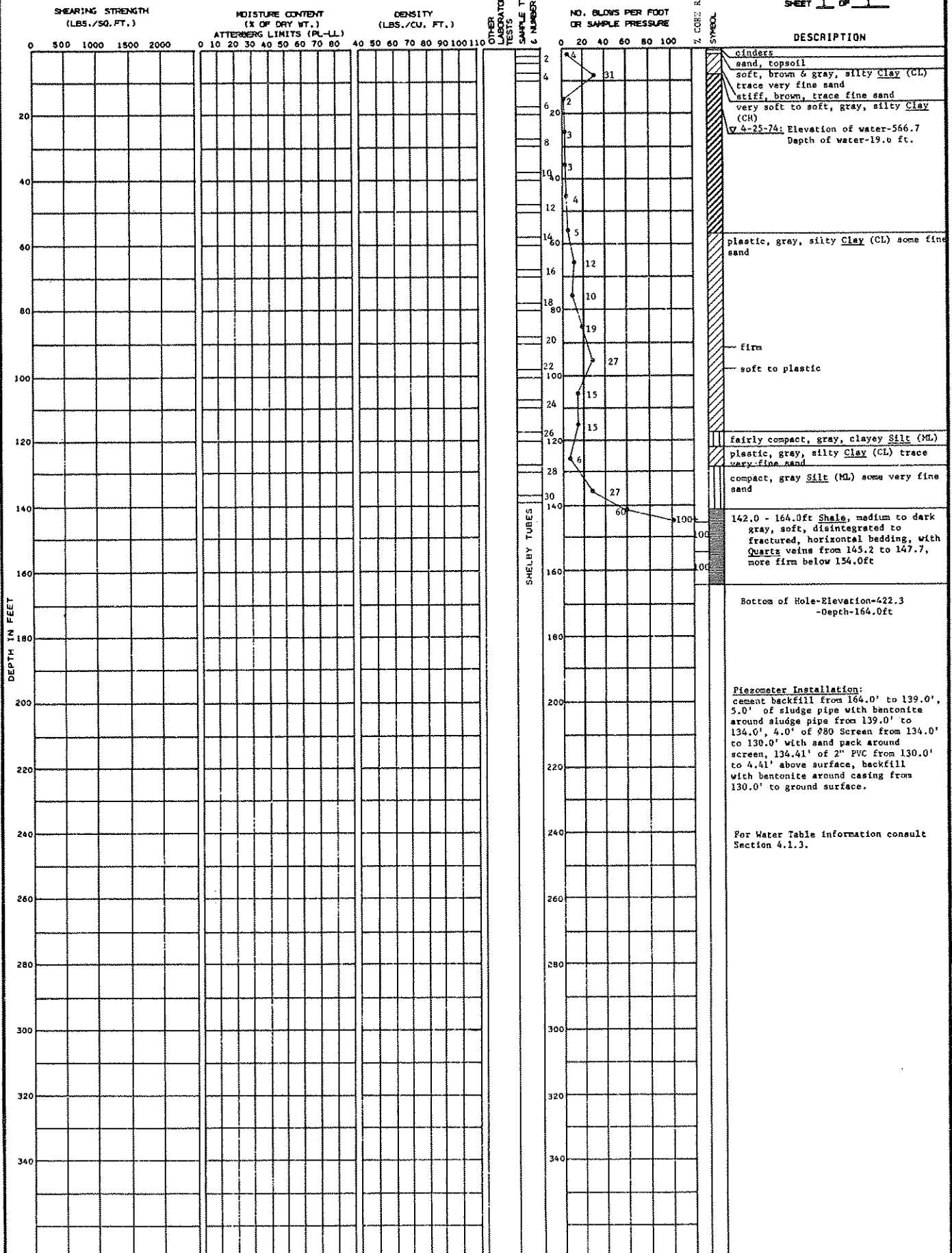


SOIL BORING NO. 22

BECHTEL Belle River

DATE DRILLED: 1-30-74
2-5-74

SHEET 1 OF 1

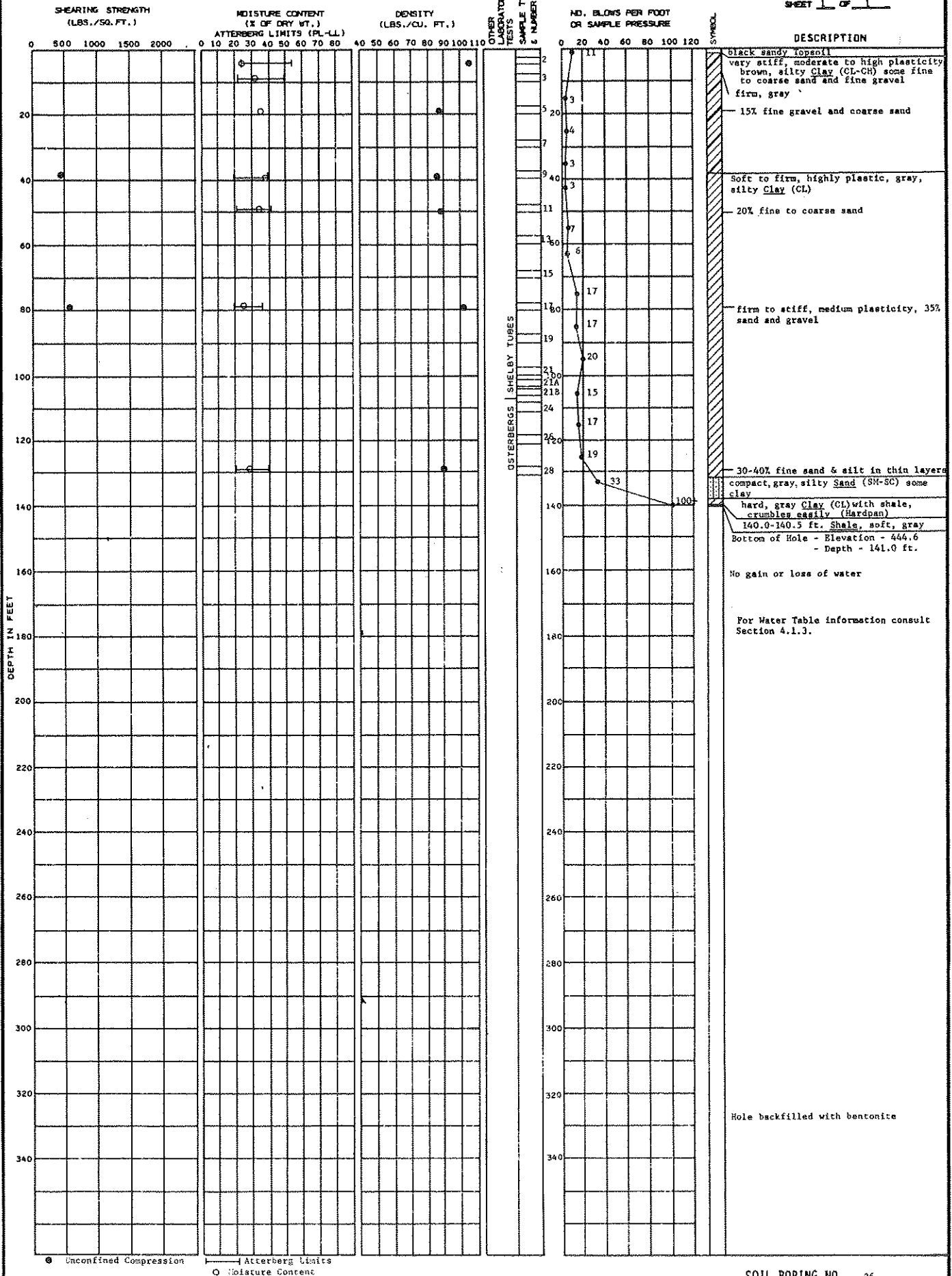
SOIL BORING NO. 24

BECHTEL Belle River

B-31

DATE DRILLED: 12-19-73

SHEET 1 OF 1

SOIL BORING NO, 26

BECHTEL Belle River

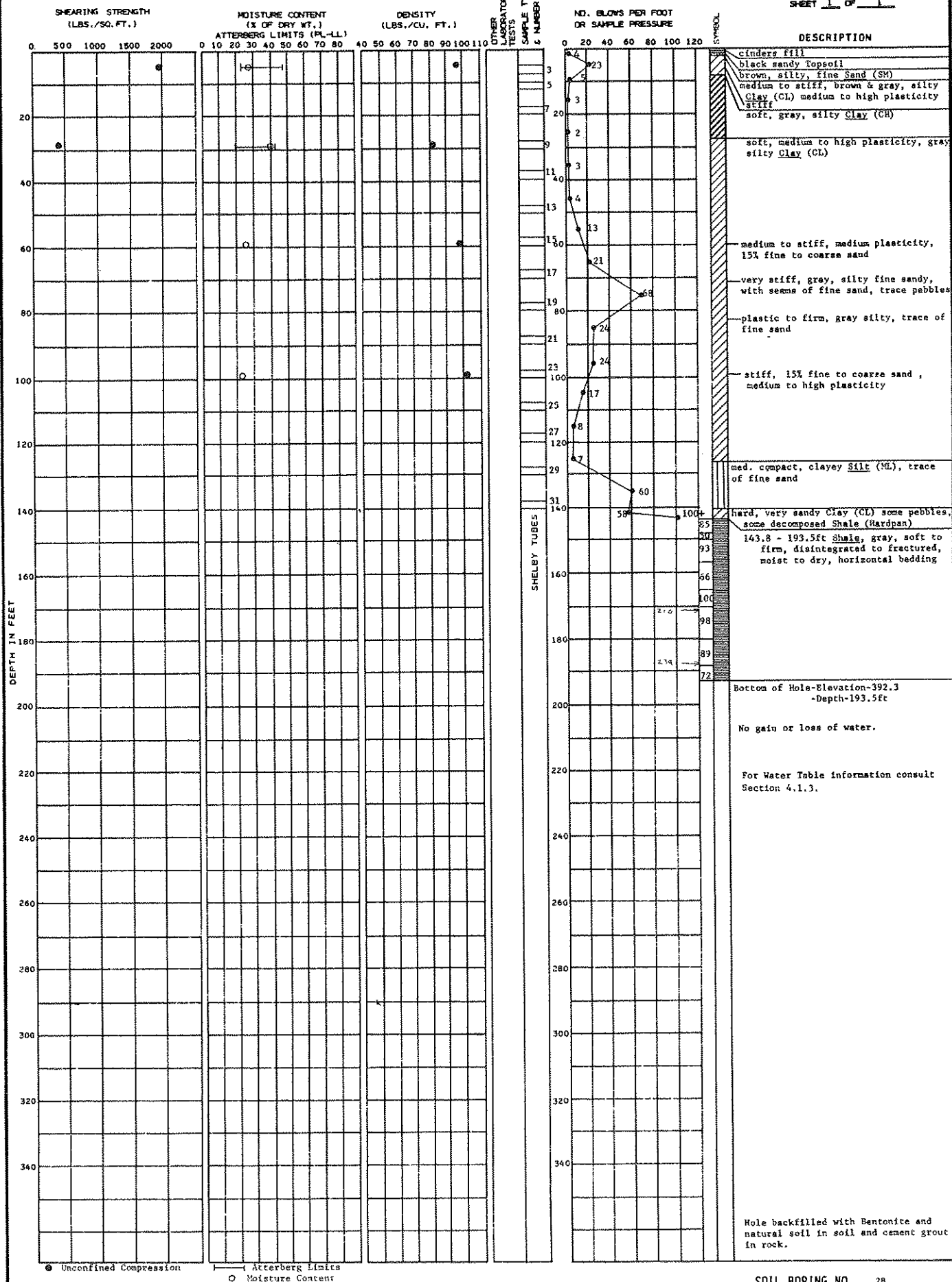
B-33

LOCATION: N 7,724
E 9,443

GROUND ELEVATION 585.8

DATE DRILLED: 1-15-74
1-22-74

SHEET 1 OF 1

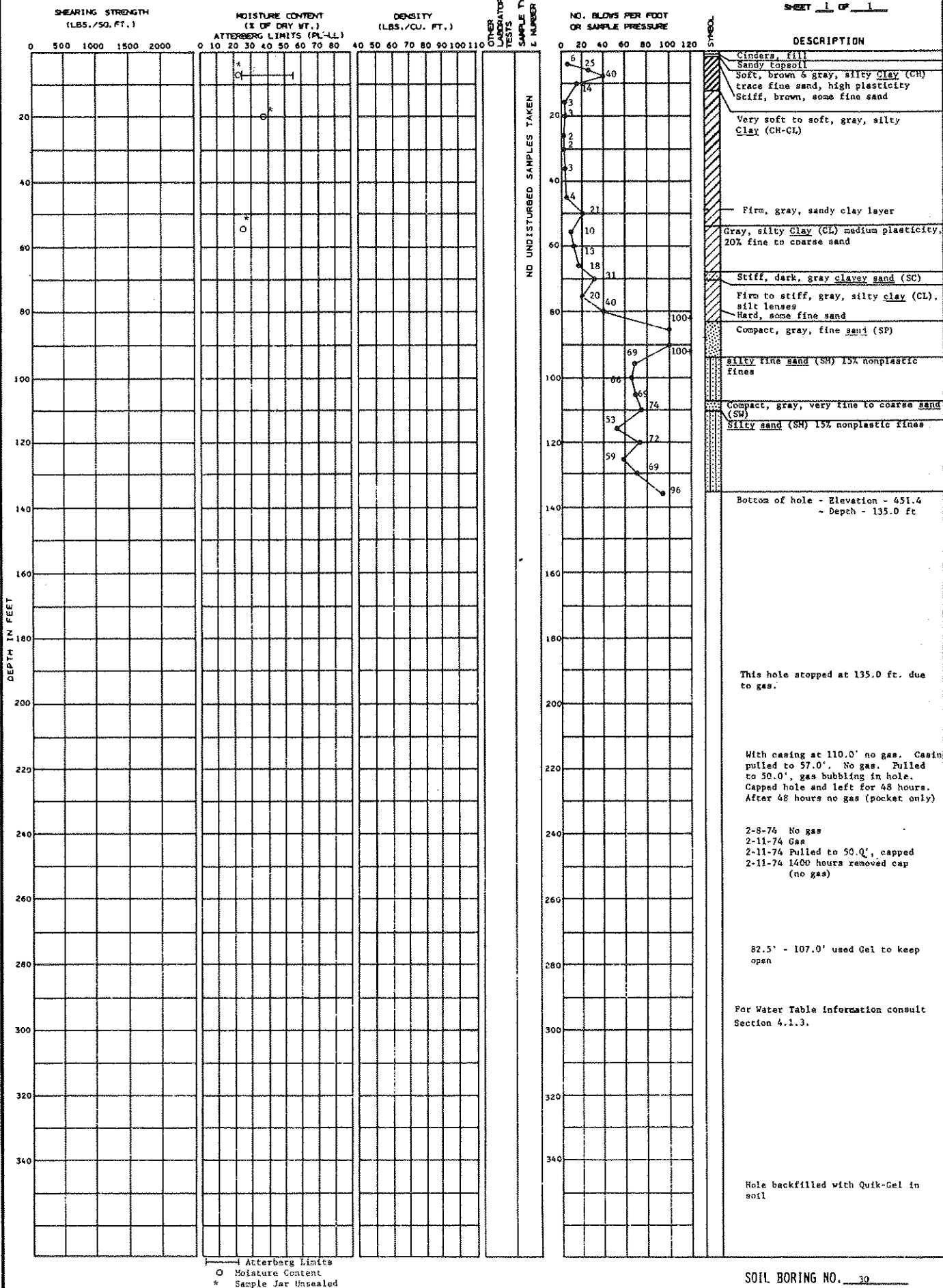


LOCATION: N 7,673
E 9,015

GROUND ELEVATION 586.4

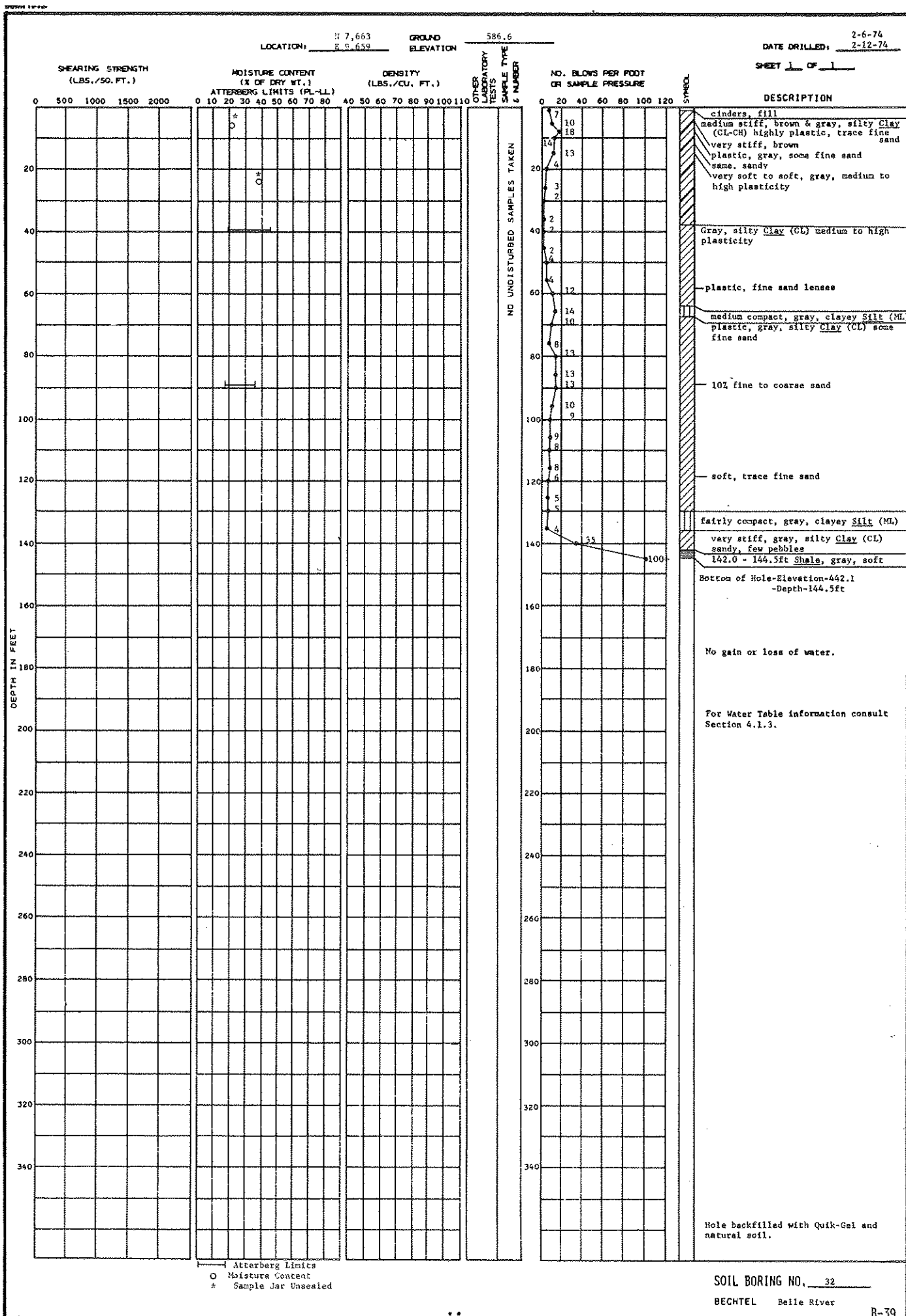
DATE DRILLED: 2-7-74
2-11-74

SHEET 1 OF 1



SOIL BORING NO. 30

BECHTEL Belle River



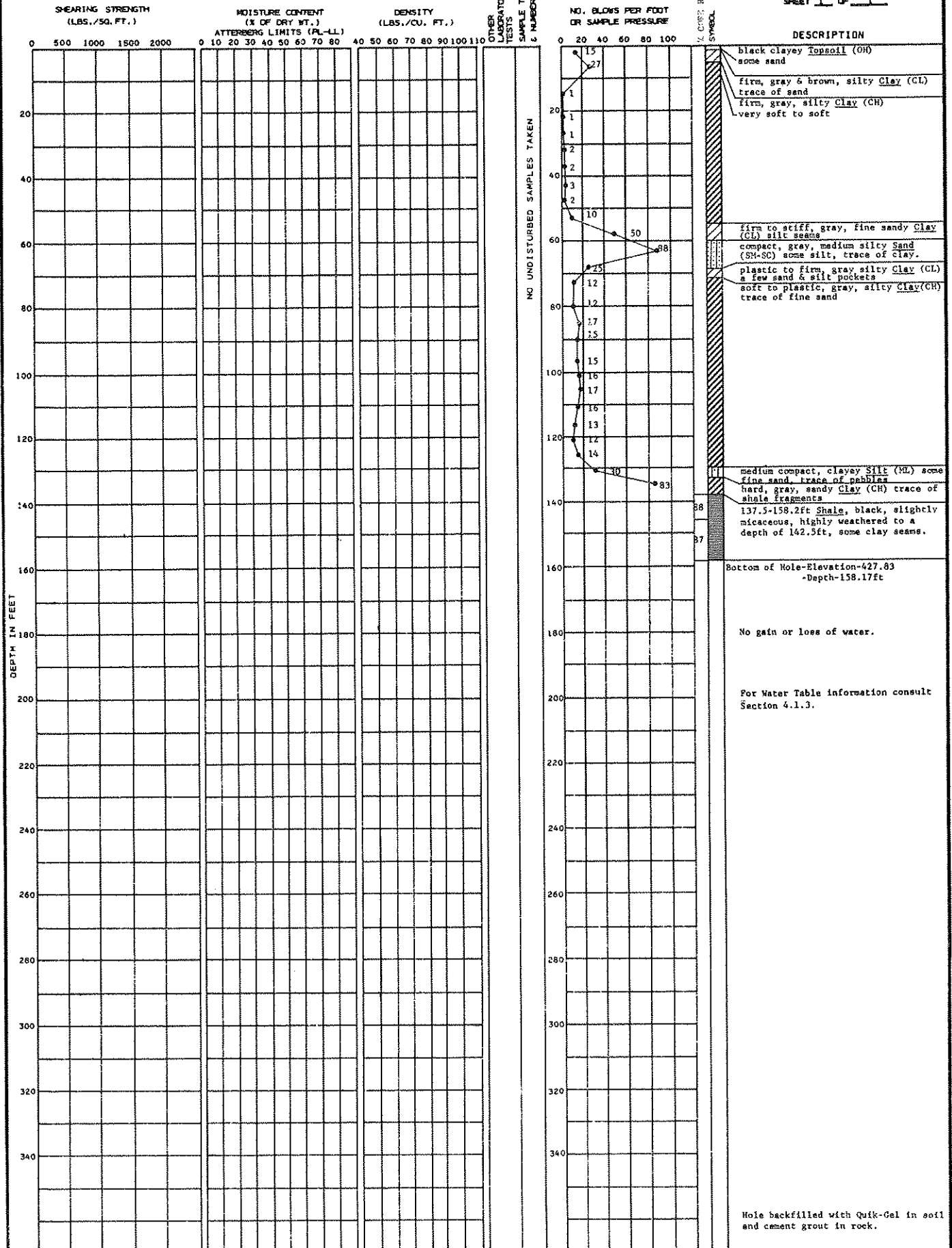
LOCATION: N 7,398
E 9,963

GROUND
ELEVATION

586.0

DATE DRILLED: 11-8-73

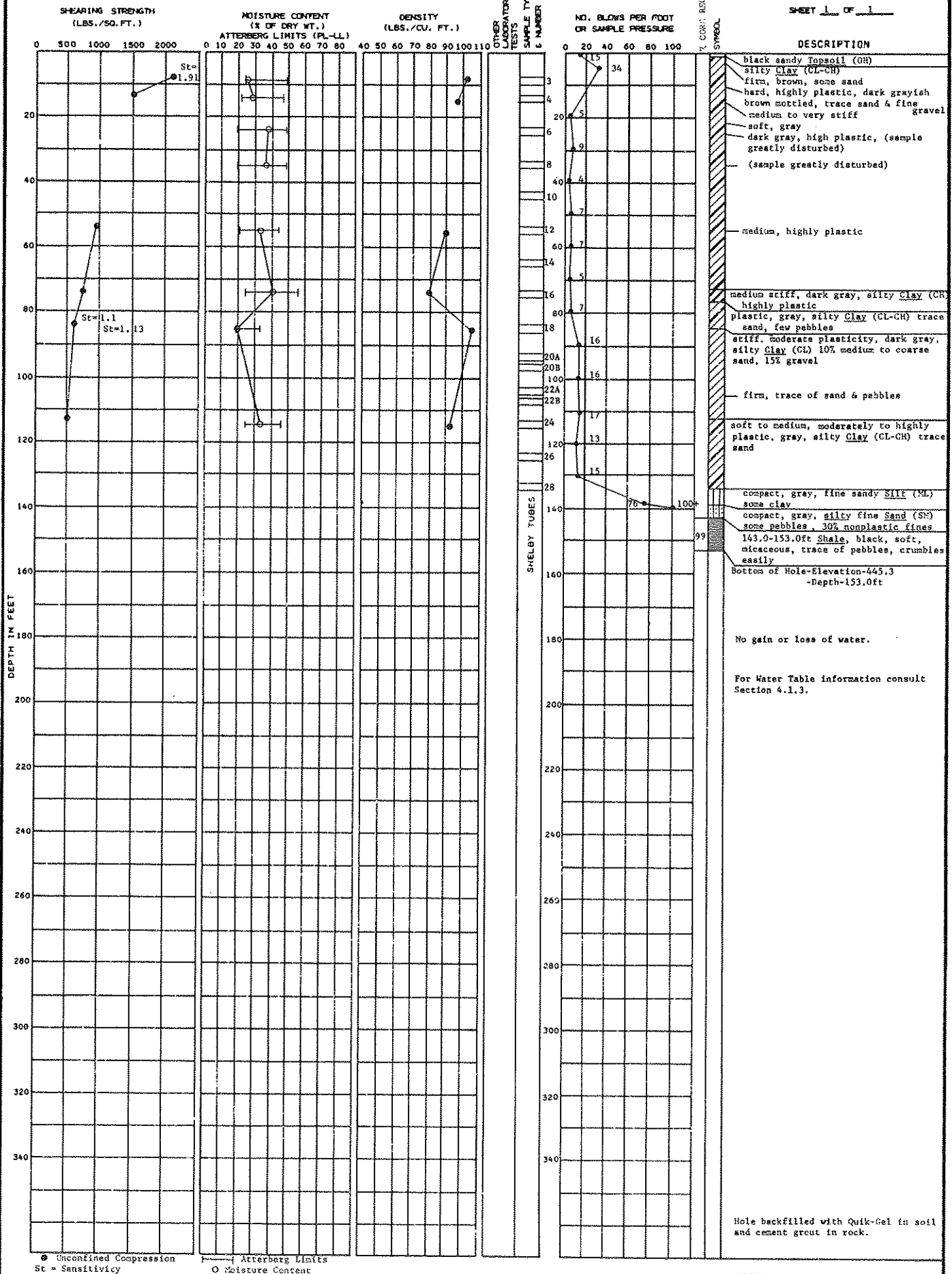
SHEET 1 OF 1



SOIL BORING NO. 34

BECHTEL Belle River

SHEET 1 OF 1

SOIL BORING NO. 38

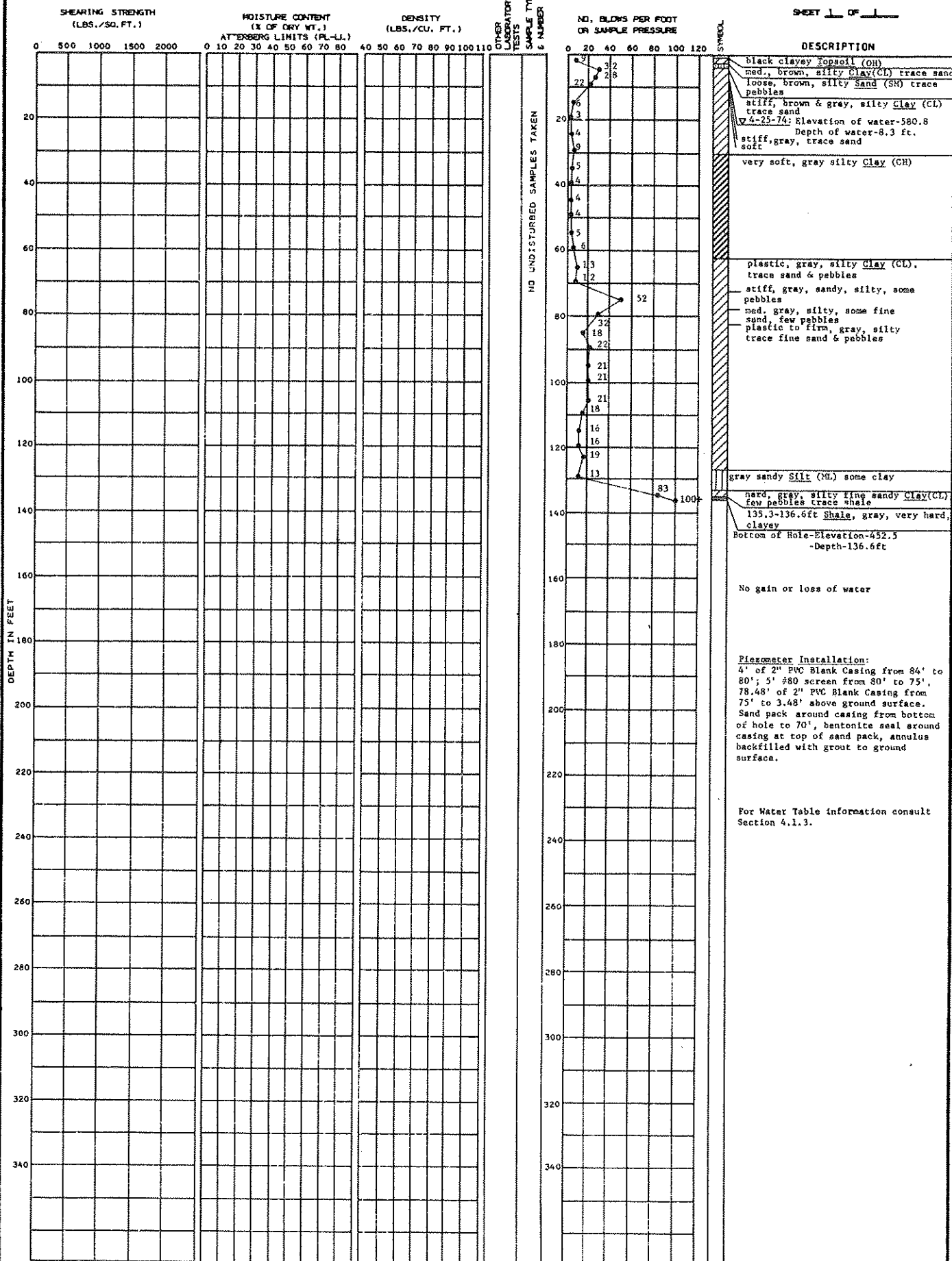
BECHTEL Belle River

LOCATION: N 8,003
E10.993GROUND
ELEVATION

589.1

DATE DRILLED: 12-14-73
12-18-73

SHEET 1 OF 1



SOIL BORING NO. 40

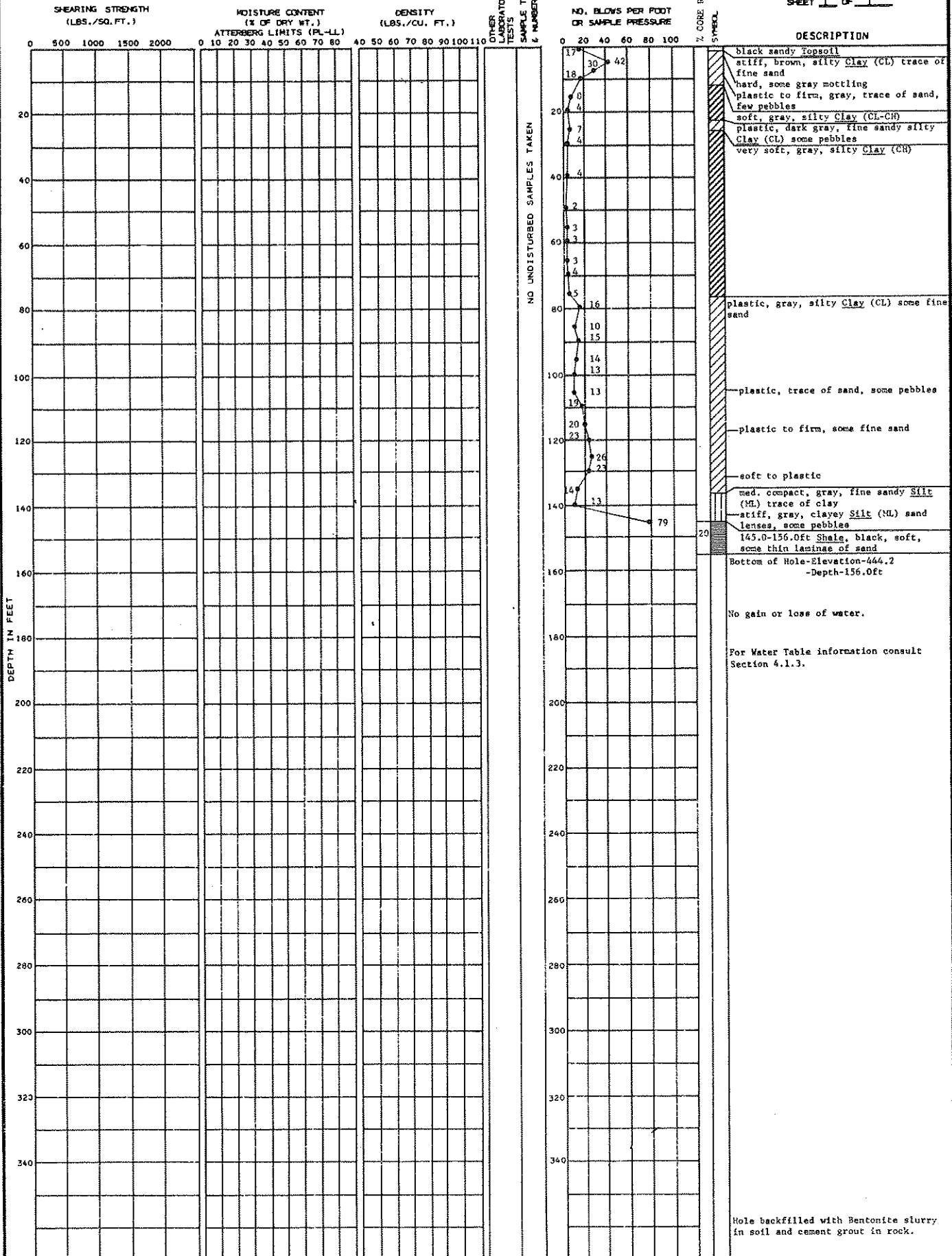
BECHTEL Belle River

LOCATION: N 8,016
E 12,991

GROUND
ELEVATION 500.2

DATE DRILLED: 11-19-73
11-21-73

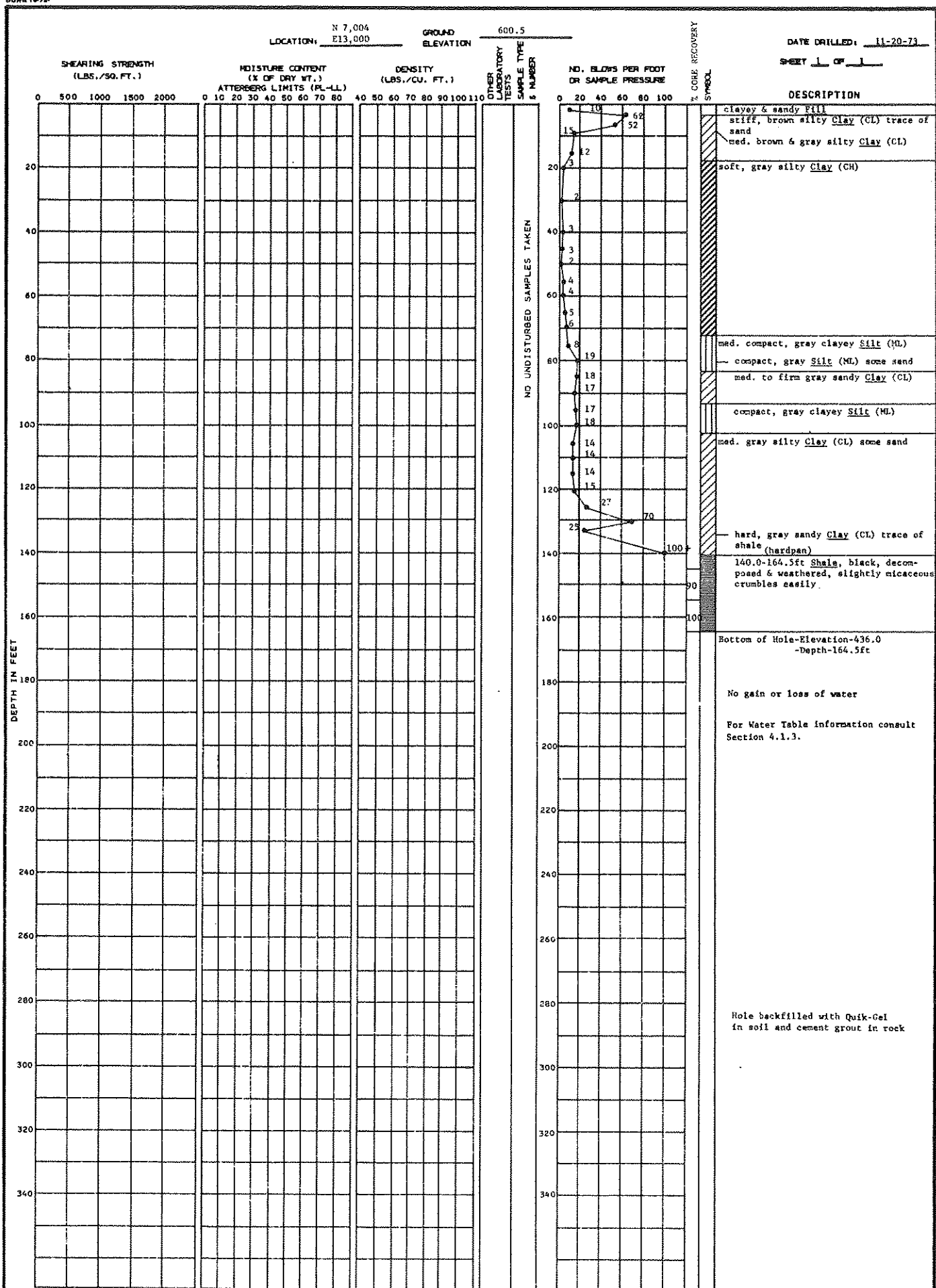
SHEET 1 OF 1



SOIL BORING NO. 42

BECHTEL Belle River

B-47



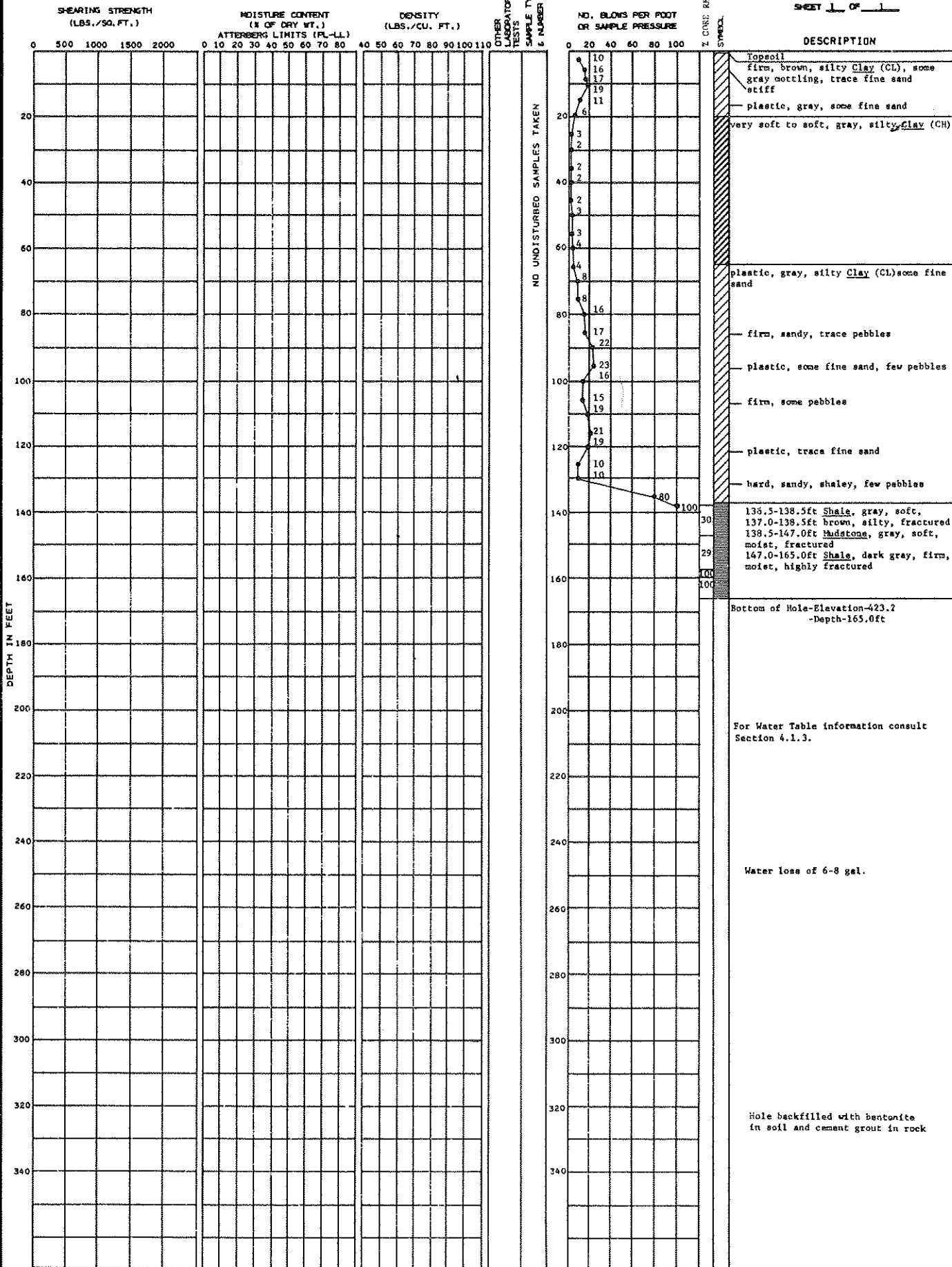
LOCATION: N 5,344
E 12,319

GROUND
ELEVATION

588.2

DATE DRILLED: 1-22-74
1-28-74

SHEET 1 OF 1



SOIL BORING NO. 46-A

BECHTEL Belle River

B-51

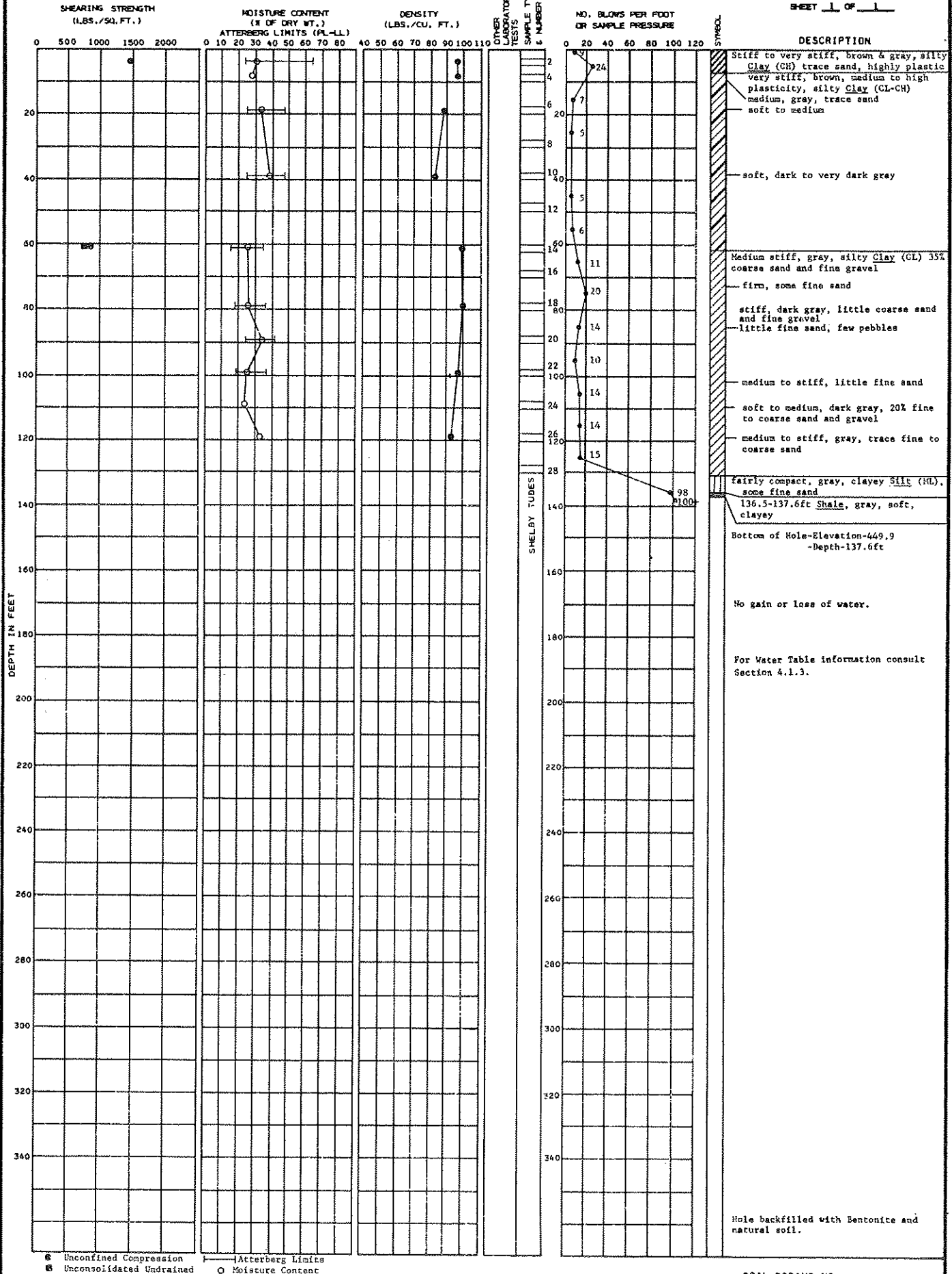
LOCATION: N 3,950
E 12,584

GROUND
ELEVATION

587.5

DATE DRILLED: 1-14-74
1-23-74

SHEET 1 OF 1



SOIL BORING NO. 48

BECHTEL Belle River

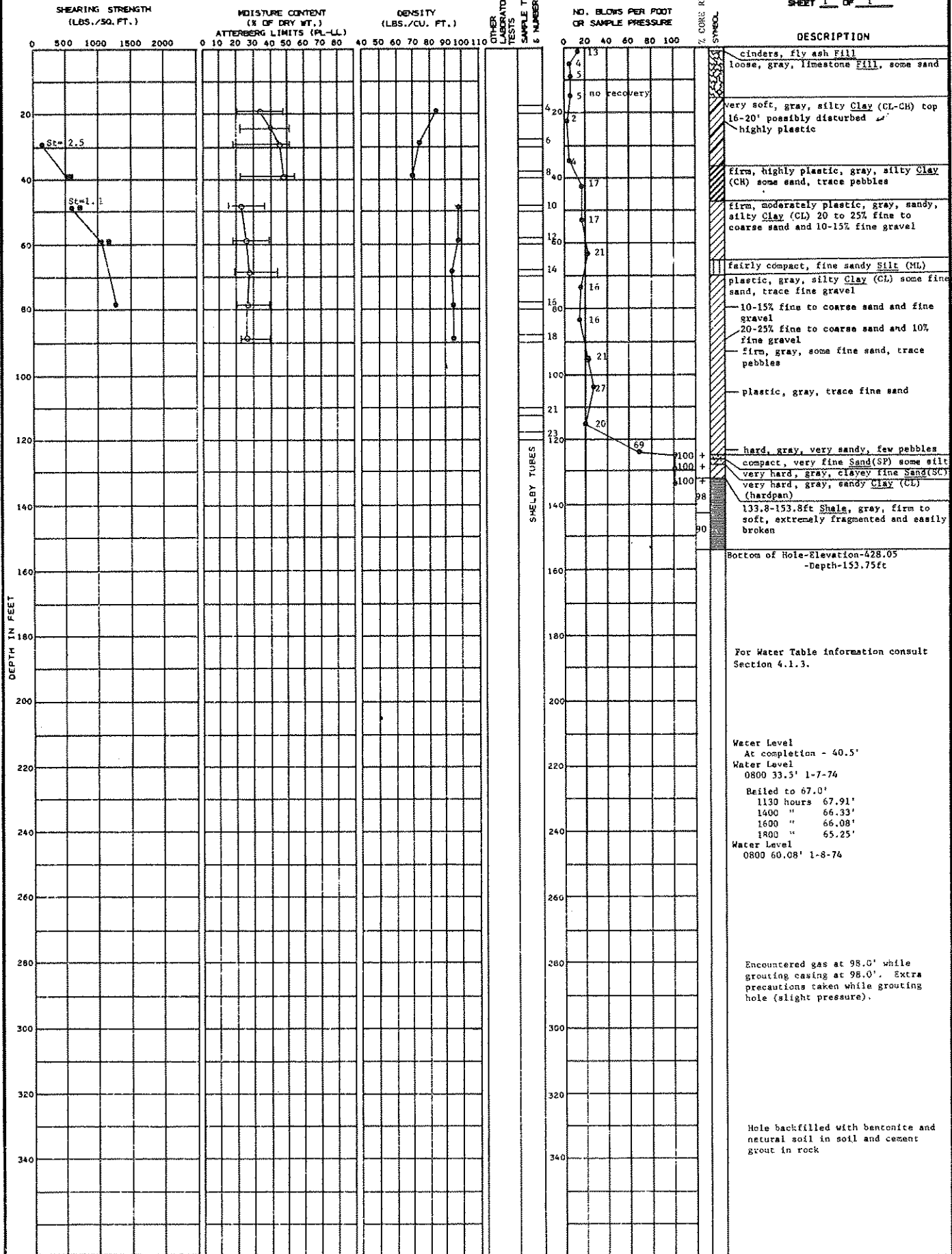
B-53

LOCATION: N 2,951
E15.471

GROUND ELEVATION 581.8

DATE DRILLED: 12-19-73
1-8-74

SHEET 1 OF 1



SOIL BORING NO. 50

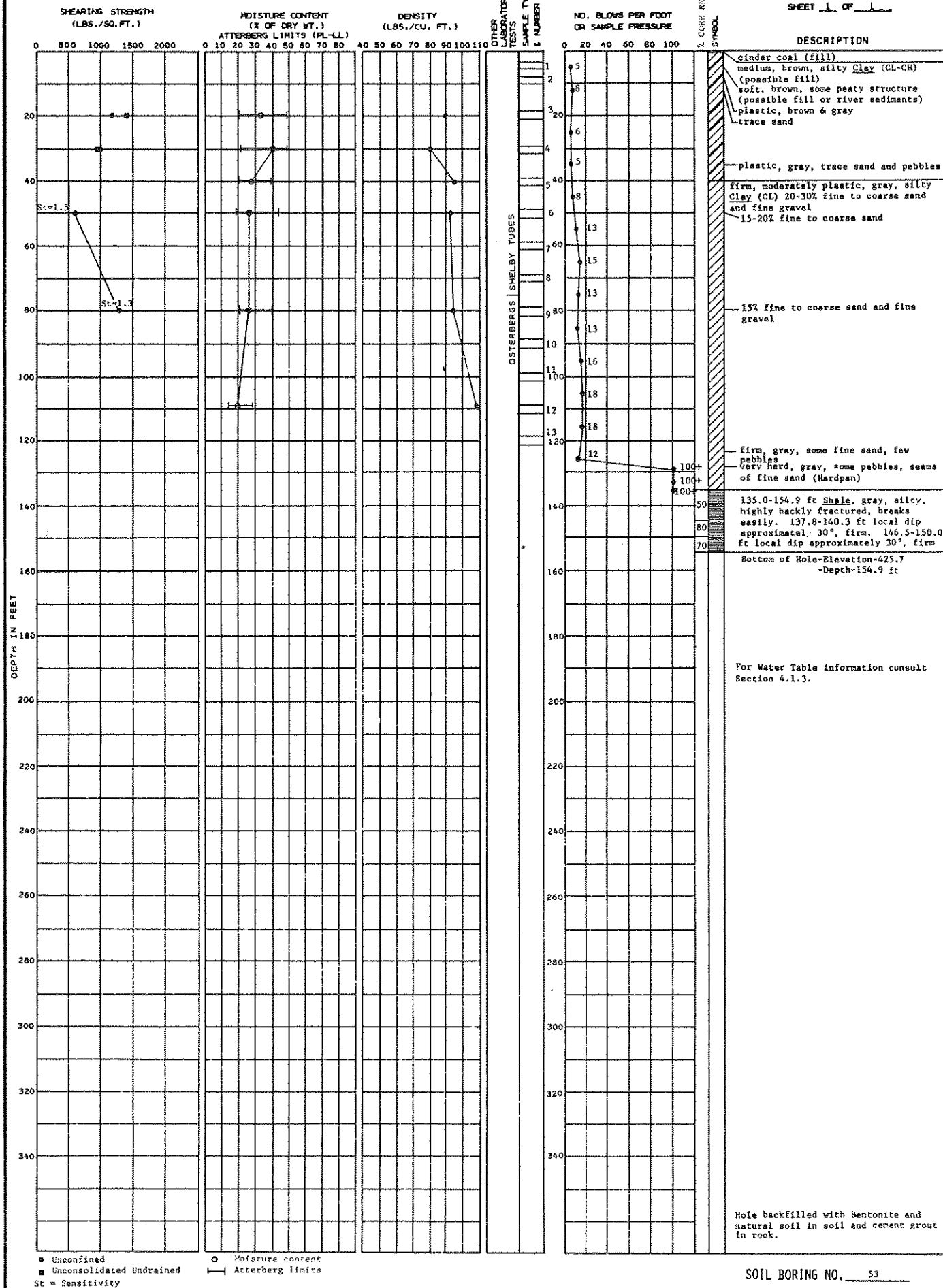
BECHTEL Belle River

LOCATION: N 2,052
E15,176

GROUND ELEVATION 580.6

DATE DRILLED: 12-21-73
1-7-74

SHEET 1 OF 1

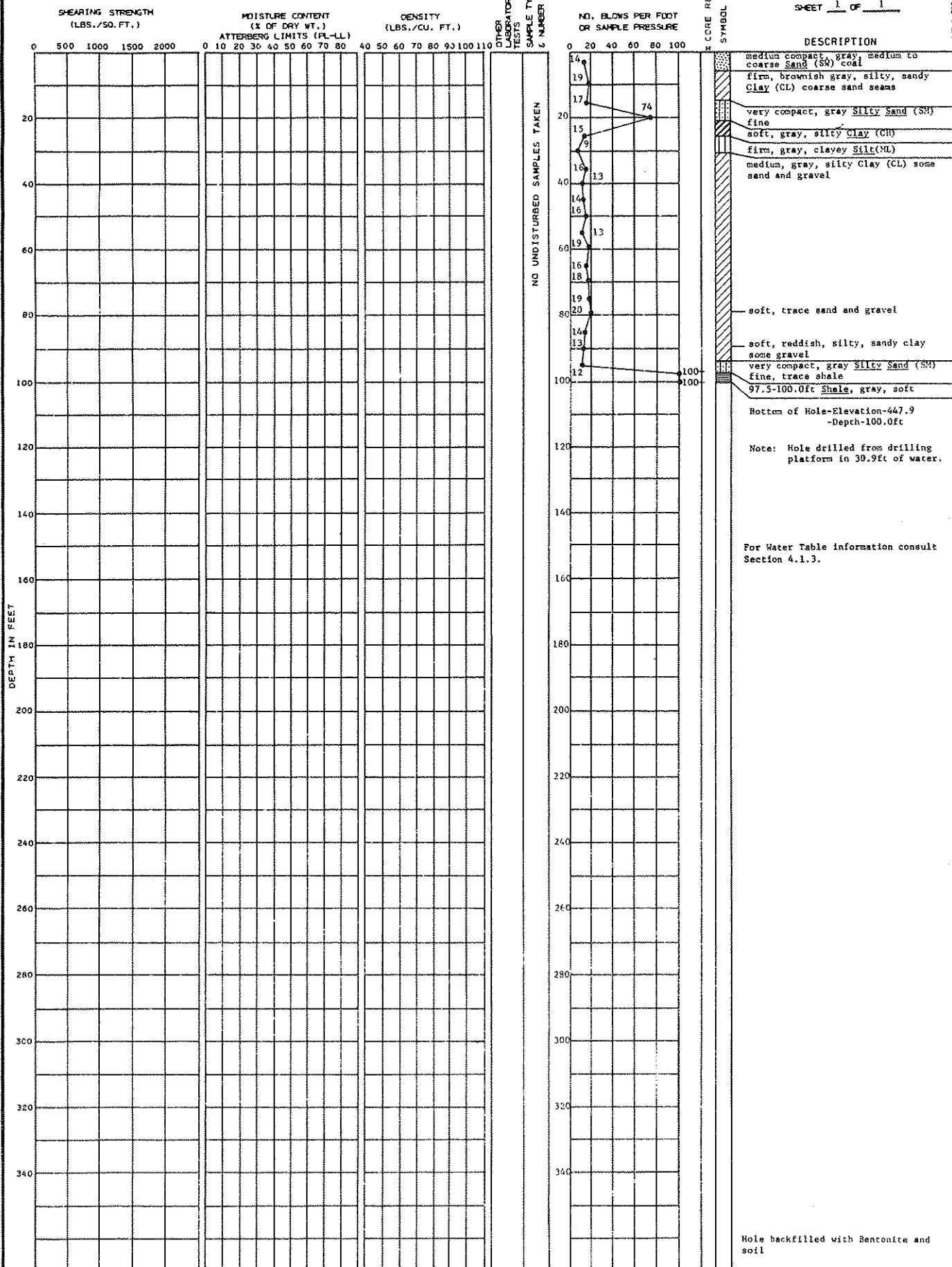


LOCATION: N 2,645
E 15,506

GROUND ELEVATION 547.9

DATE DRILLED: 3-29-74

SHEET 1 OF 1



SOIL BORING NO. 55

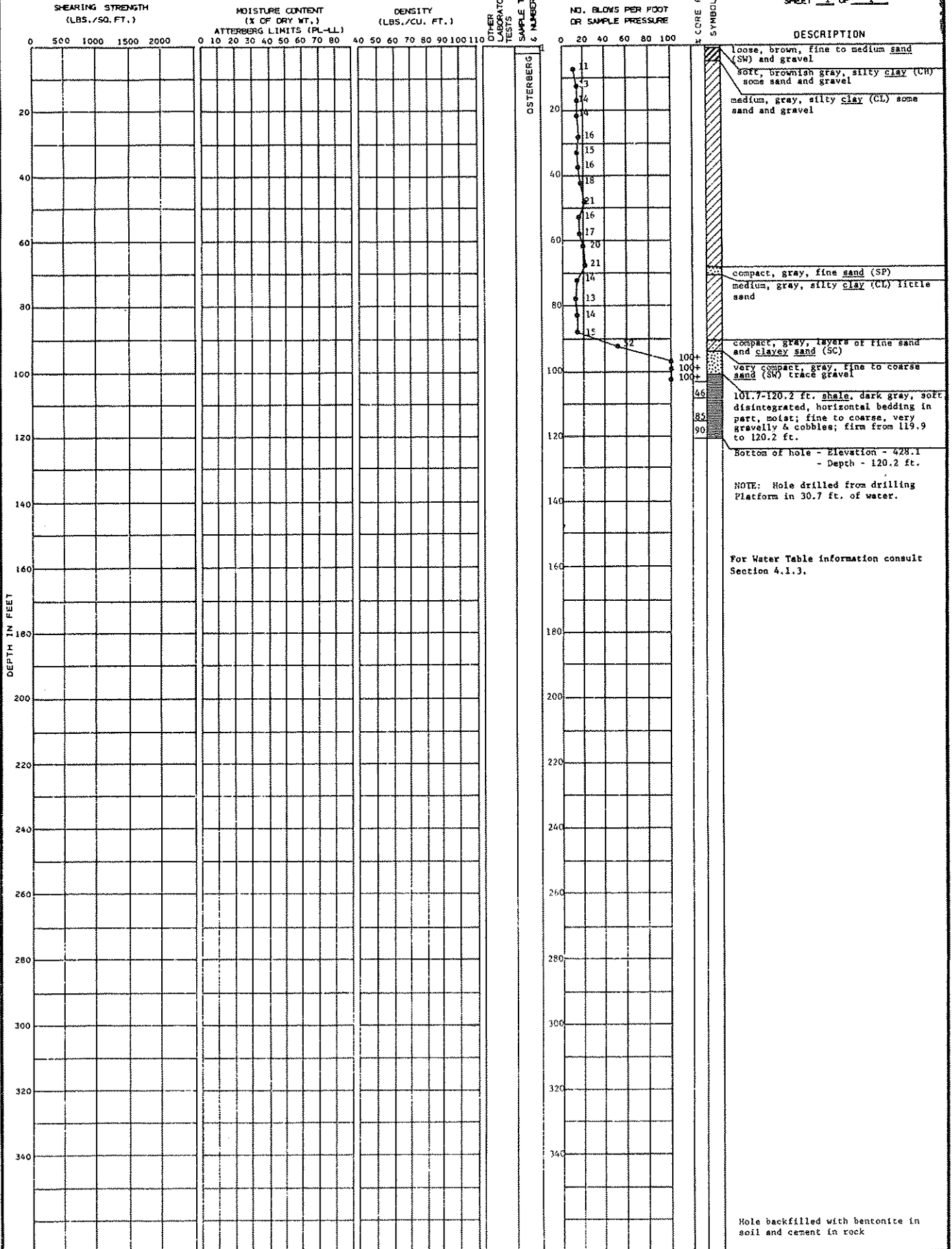
BECHTEL Belle River

LOCATION: N 1,907
E 15,269

GROUND ELEVATION 543.3

DATE DRILLED: 3-20-74
3-26-74

SHEET 1 OF 1

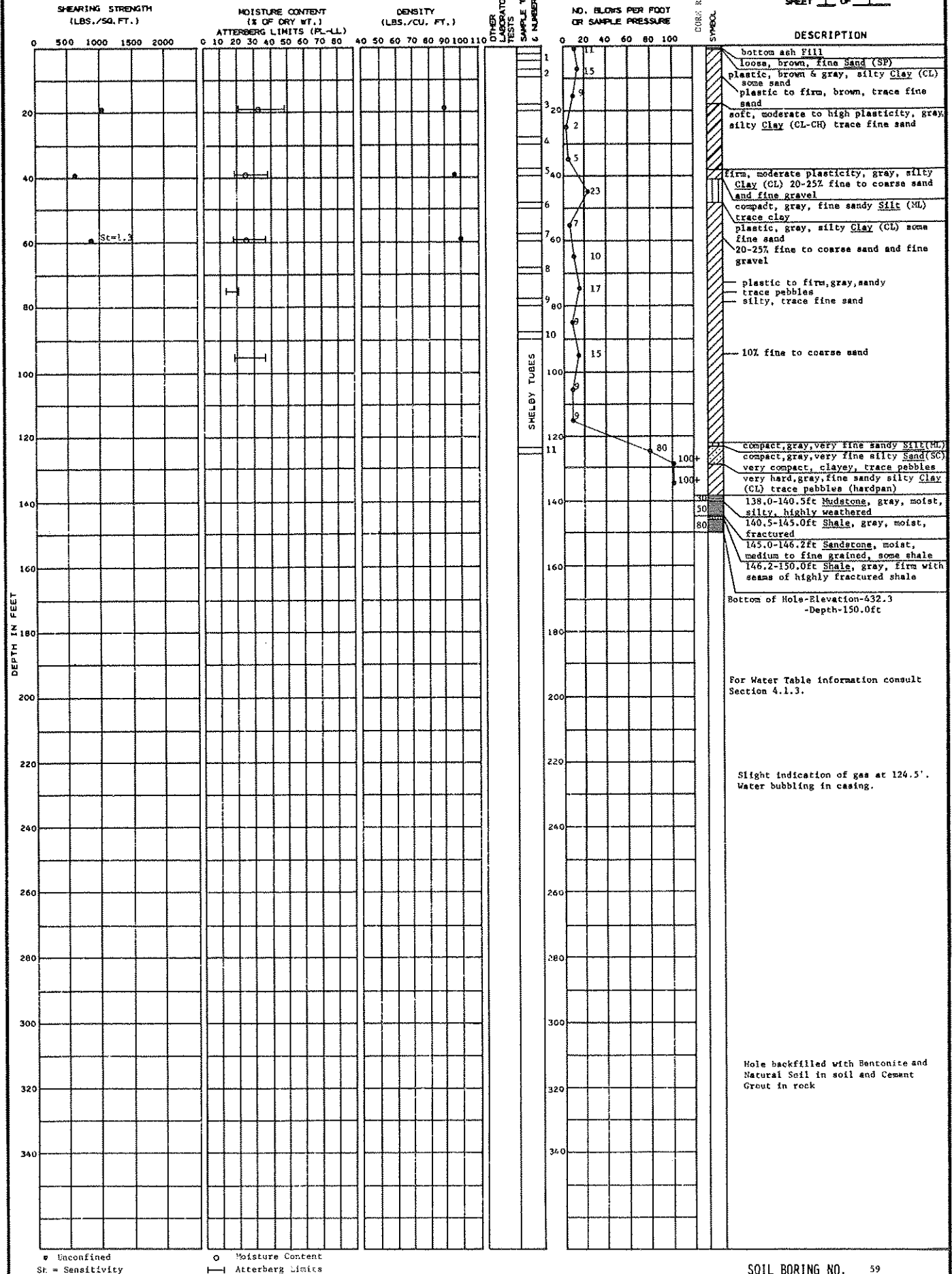


LOCATION: N 2393
E13140

GROUND ELEVATION 582.3

DATE DRILLED: 1-10-74
1-16-74

SHEET 1 OF 1

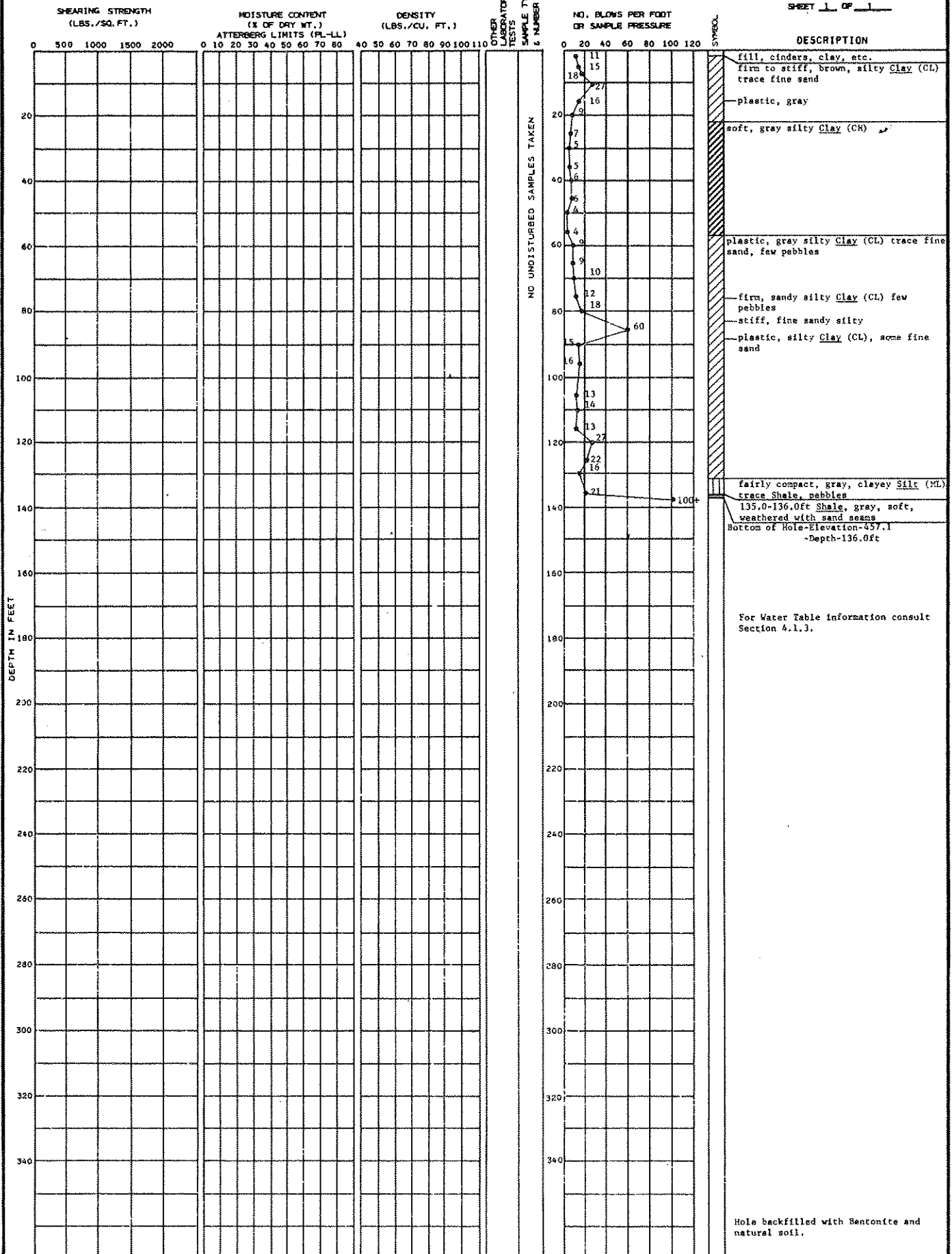


LOCATION: N 5,283
E 14,042

GROUND ELEVATION 593.1

DATE DRILLED: 1-23-74
1-29-74

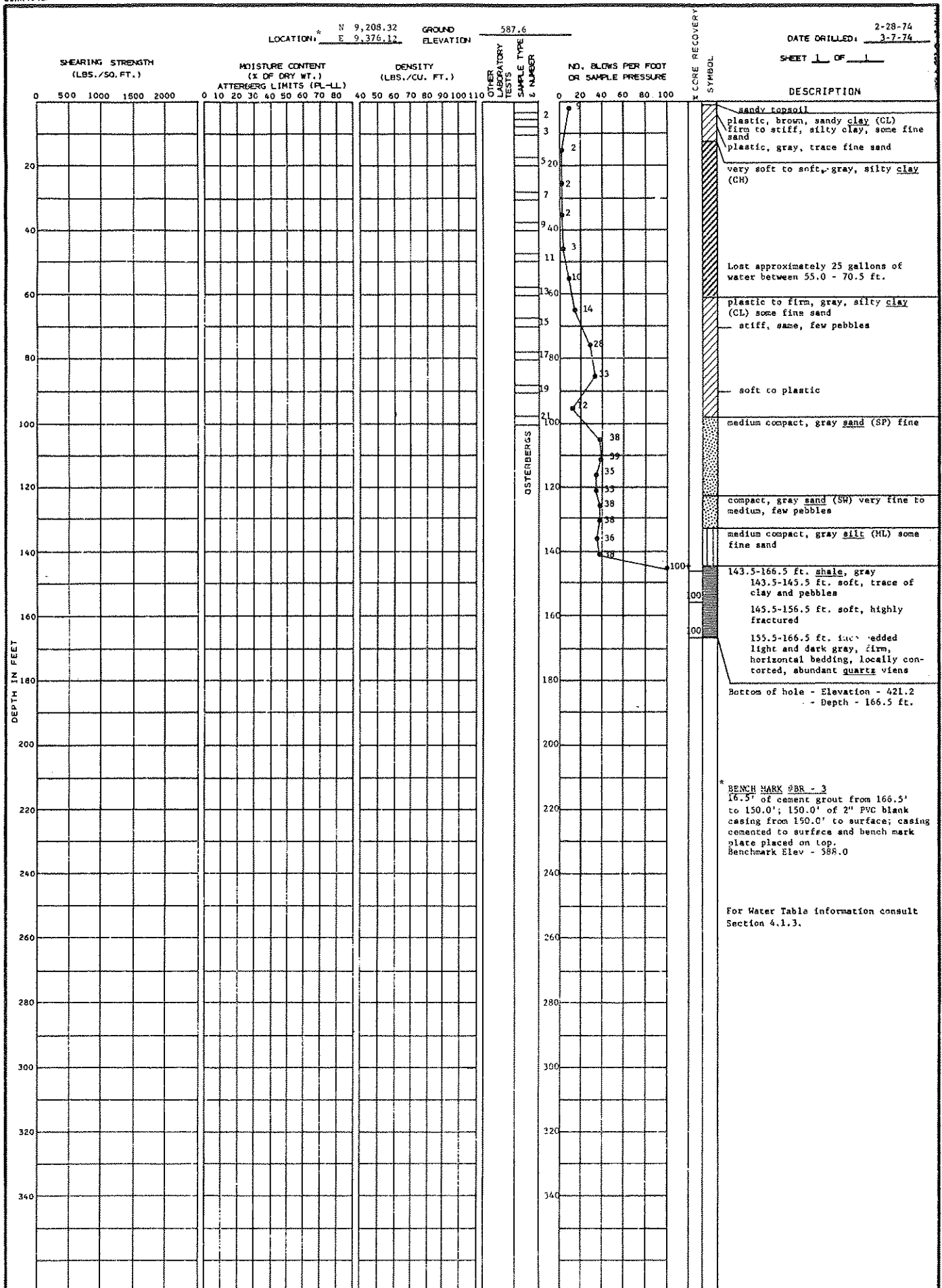
SHEET 1 OF 1



SOIL BORING NO. 63

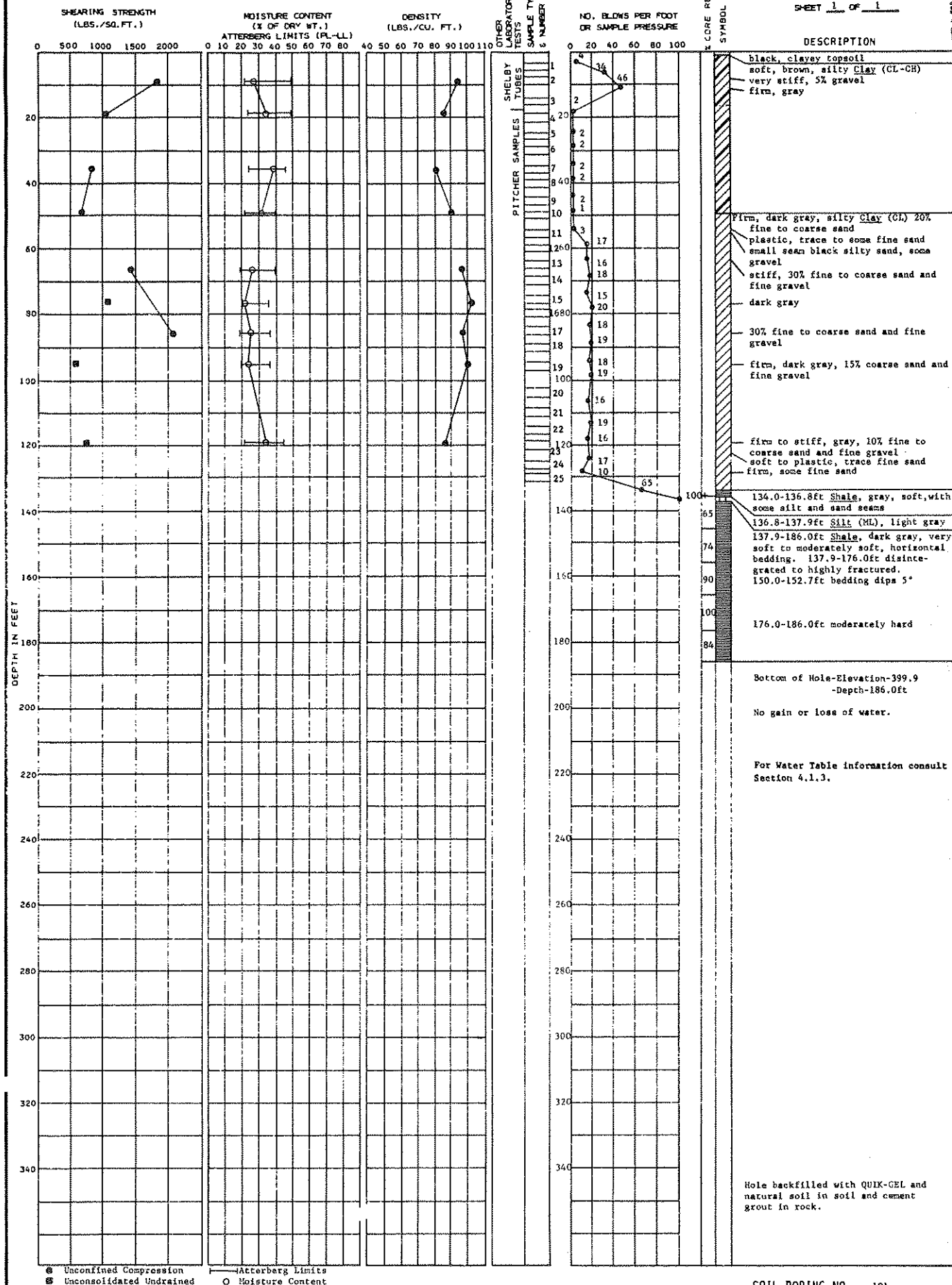
BECHTEL Belle River

B-65



LOCATION: N 3,800
E 12,060GROUND
ELEVATION 586.0DATE DRILLED: 2-12-74
2-26-74

SHEET 1 OF 1



SOIL BORING NO. 101

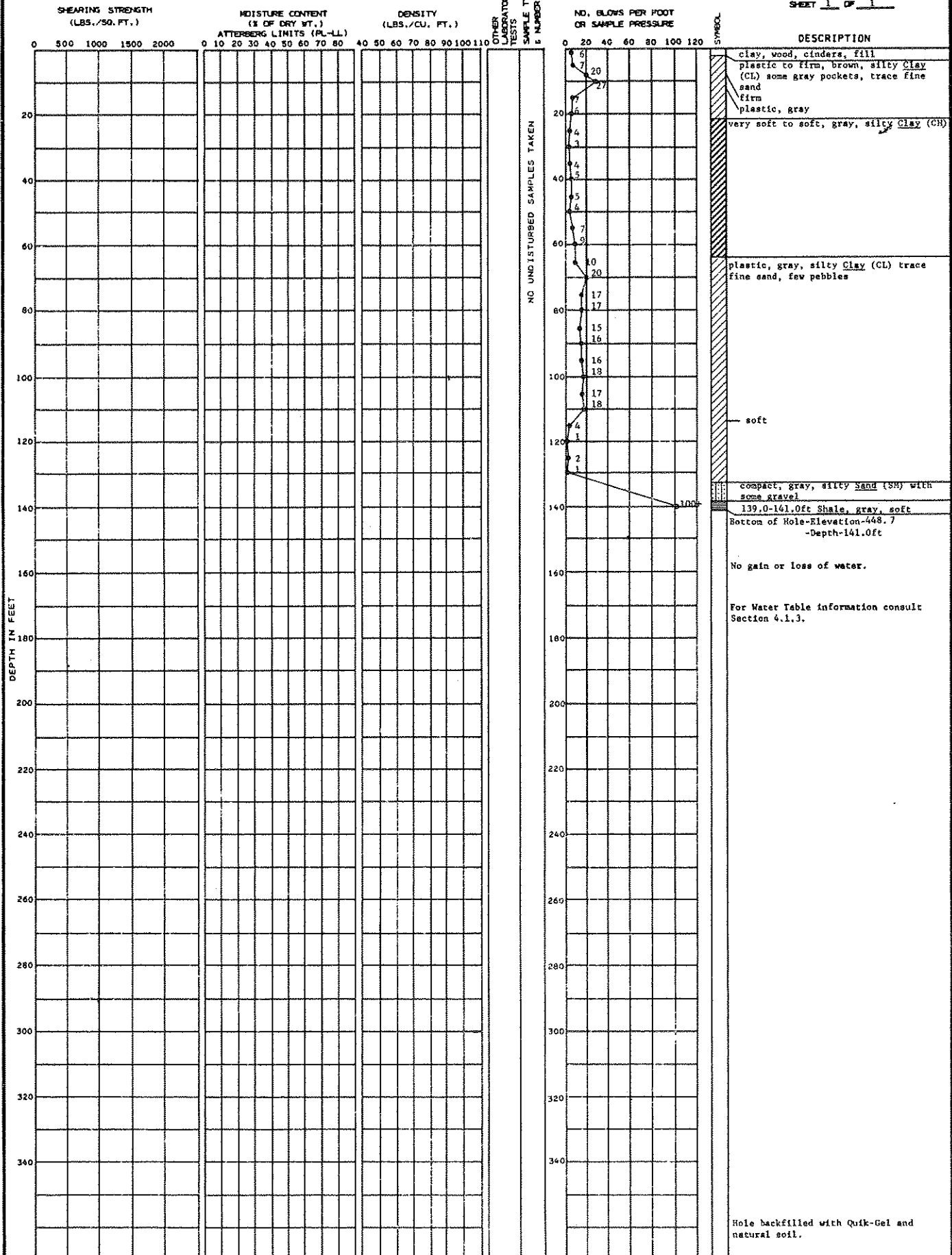
BECHTEL Belle River

LOCATION: N 4,435
E 12,350

GROUND ELEVATION 589.7

DATE DRILLED: 2-5-74
2-7-74

SHEET 1 OF 1

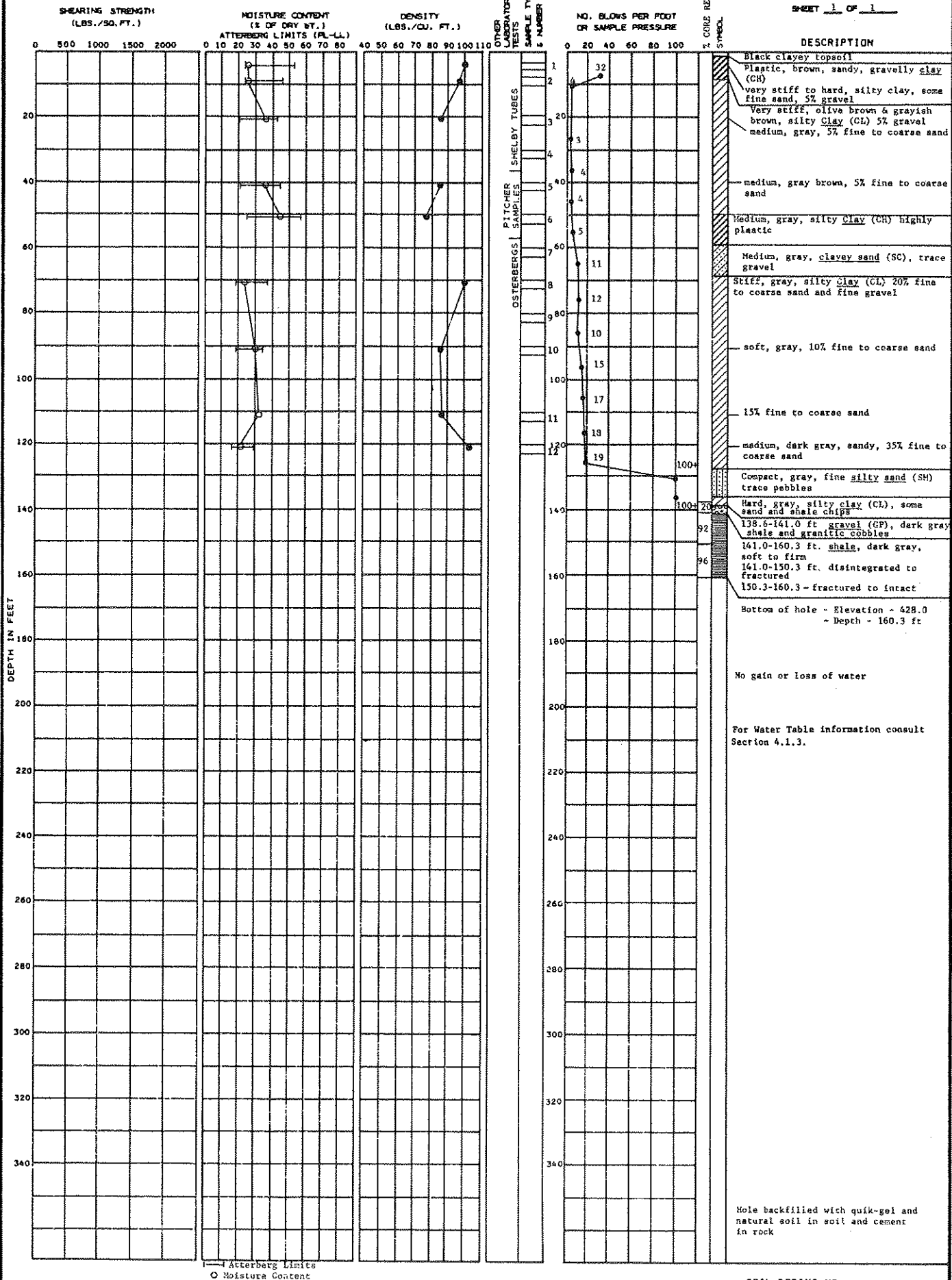


SOIL BORING NO. 103

BECHTEL Belle River

B-71

DATE DRILLED: 2-26-74
3-5-74

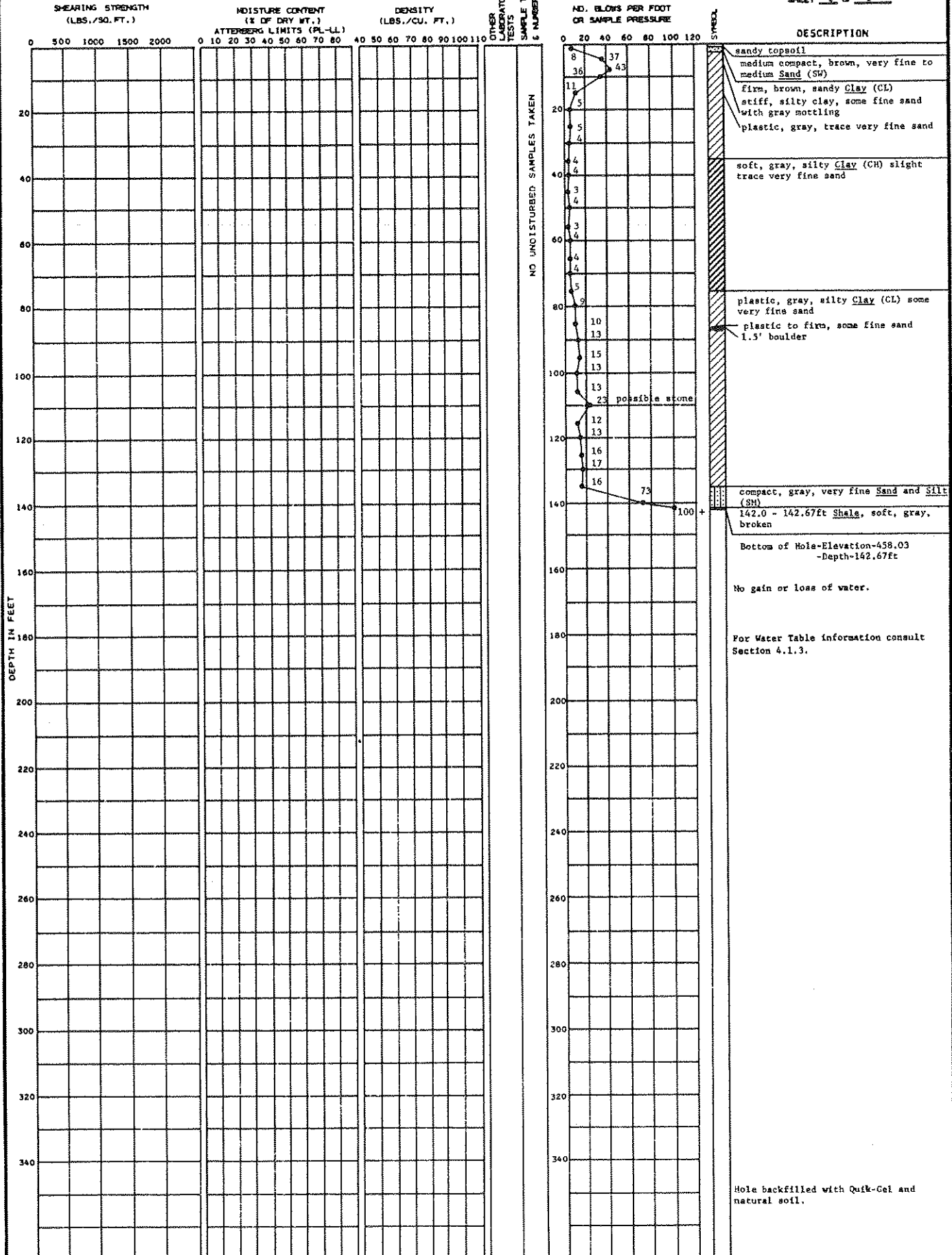


LOCATION: S 6,450
E 13,140

GROUND ELEVATION 600.7

DATE DRILLED: 2-26-74
3-6-74

SHEET 1 OF 1



SOIL BORING NO. 109

BECHTEL Belle River

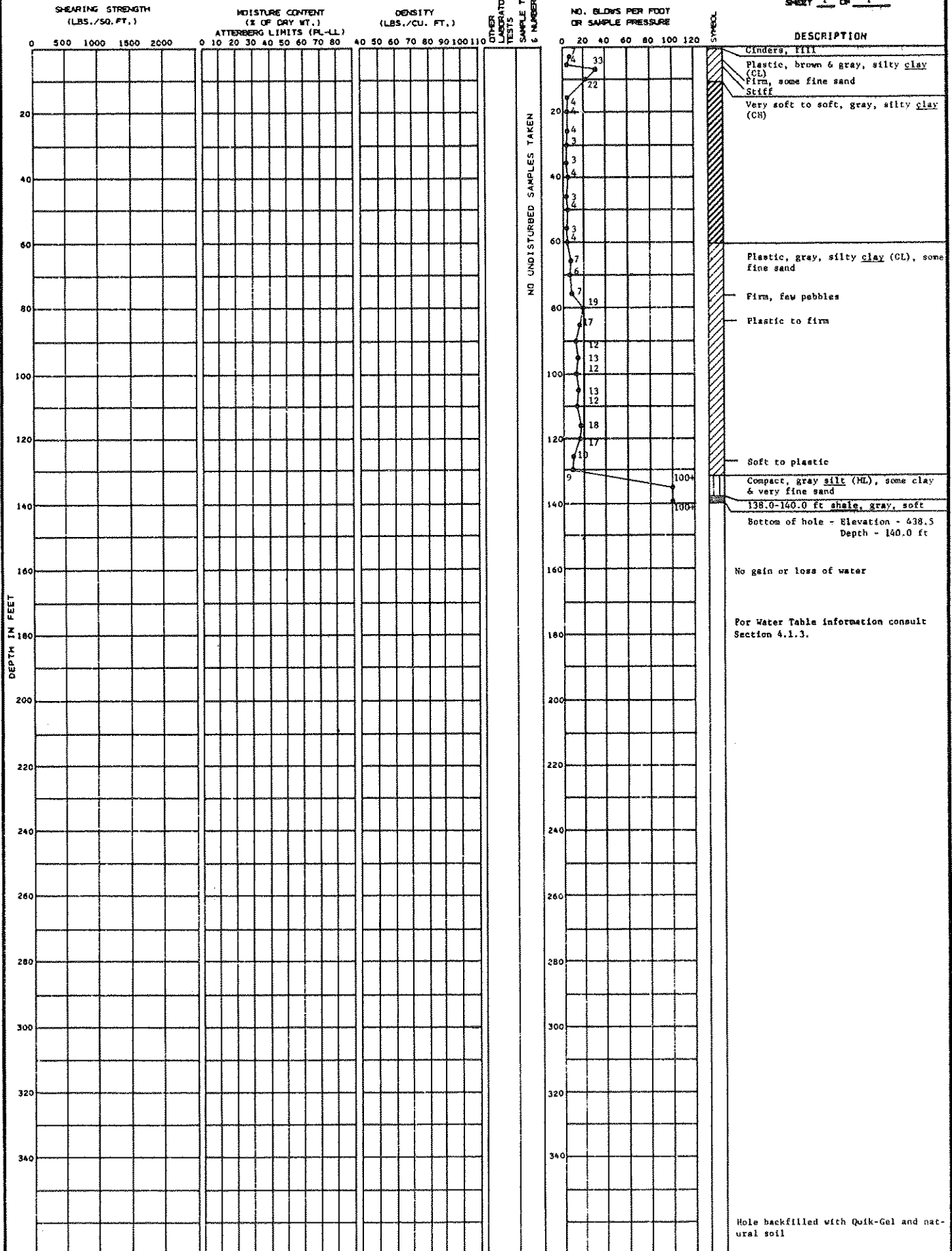
B-75

LOCATION: N 6,600
E 11,000GROUND
ELEVATION

588.5

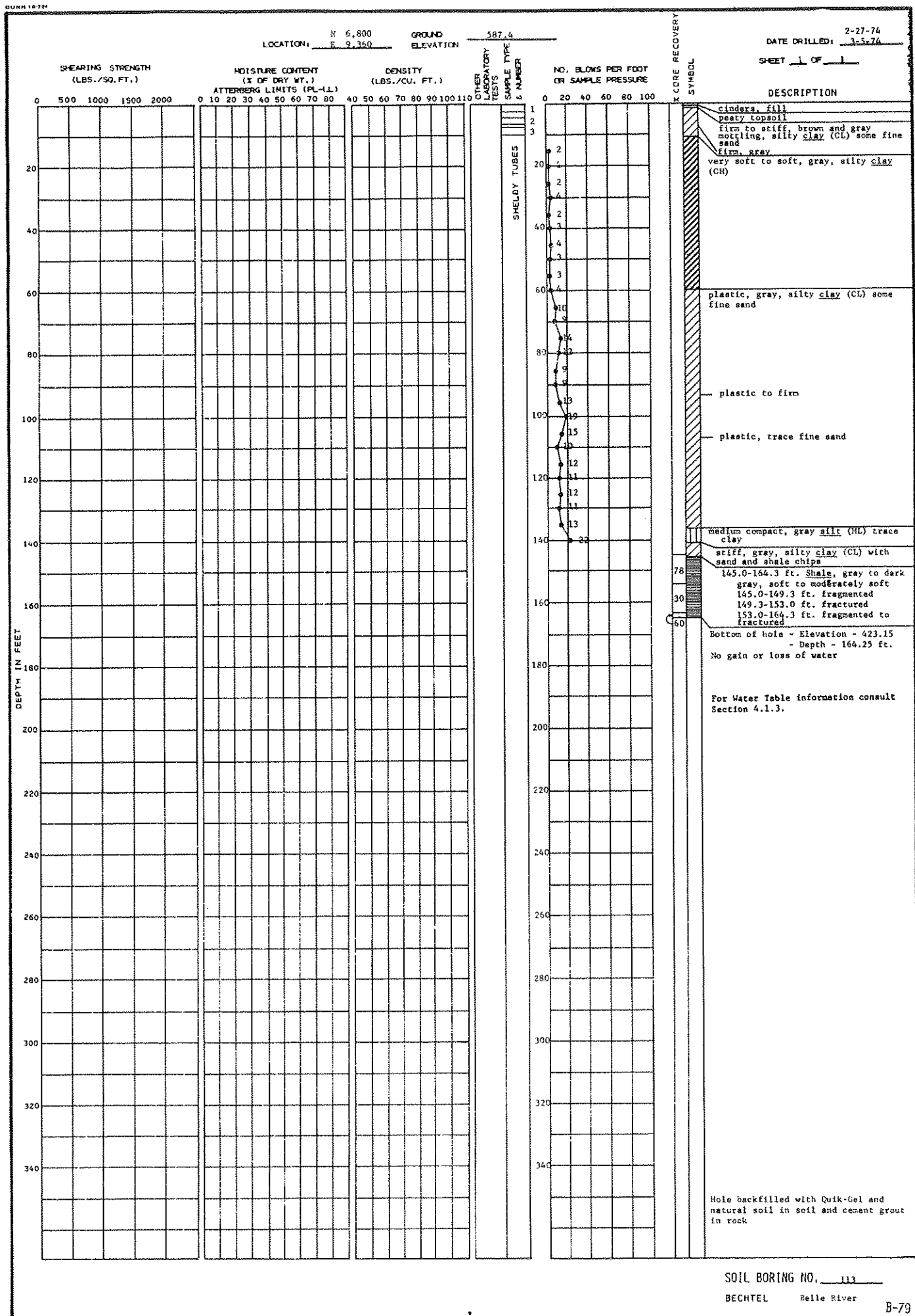
DATE DRILLED: 2-21-74
2-26-74

SHEET 1 OF 1



SOIL BORING NO. 111

BECHTEL Belle River



LOCATION: N 7,100 E13,260		GROUND ELEVATION: 600.7		DATE DRILLED: 1-30-74 2-5-74																							
SHEARING STRENGTH (LBS./SQ. FT.)		MOISTURE CONTENT (% OF DRY WT.) ATTERBERG LIMITS (PL-LL)		DENSITY (LBS./CU. FT.)																							
0	500	1000	1500	2000	0	10	20	30	40	50	60	70	80	40	50	60	70	80	90	100	110						
DEPTH IN FEET																						OTHER LABORATORY TESTS		NO. BLOWS PER FOOT OR SAMPLE PRESSURE		DESCRIPTION	
																						SAMPLE TYPE					
1																						16	sandy topsoil				
2																						33	stiff, brown, Clay (CL)				
3																						7	stiff, gray, silty sandy				
4																						5	soft, trace fine sand				
5																						5	very soft to soft, gray, silty Clay (CH)				
6																						4					
7																						4					
8																						4					
9																						7	plastic, gray, silty Clay (CL) some fine sand				
10																						10					
11																						8					
12																						10					
13																						13					
14																						13					
15																						14					
16																						100+	compact, gray Silt (ML)				
17																						100+	compact, gray, silty, very fine Sand (SM)				
18																							142.0-144.0ft Shale, gray, soft				
19																							Bottom of Hole-Elevation-456.7				
20																							-Depth-144.0ft				
21																							For Water Table information consult Section 4.1.3.				
22																							No Gain or Loss of Water				
23																											
24																											
25																											
26																											
27																											
28																											
29																											
30																											
31																											
32																							Hole Backfilled With Quick-Gel and Natural Soil				
33																											
34																											

SOIL BORING NO. 115

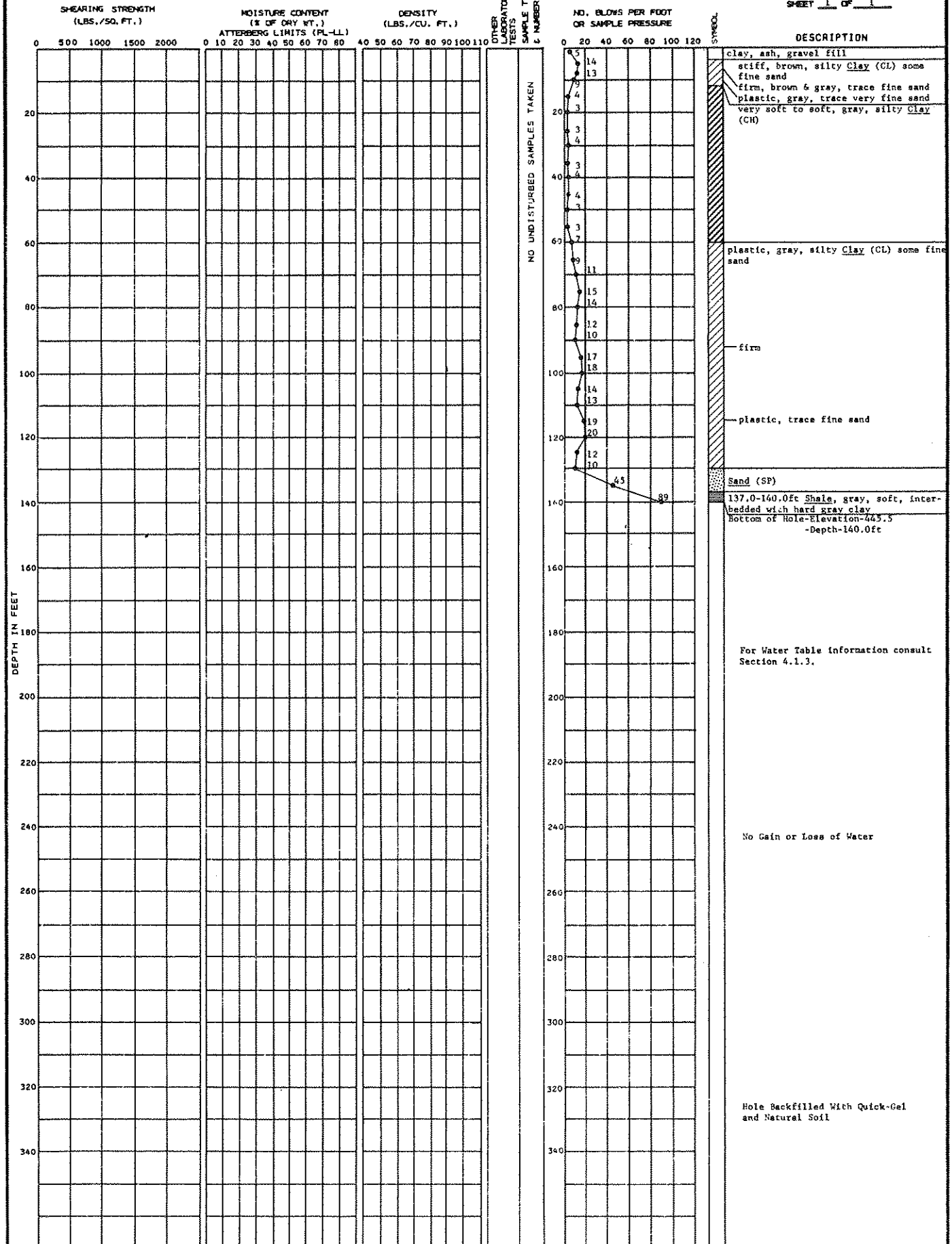
BECHTEL Belle River

LOCATION: N 7,270
E 9,360

 GROUND
ELEVATION 585.5

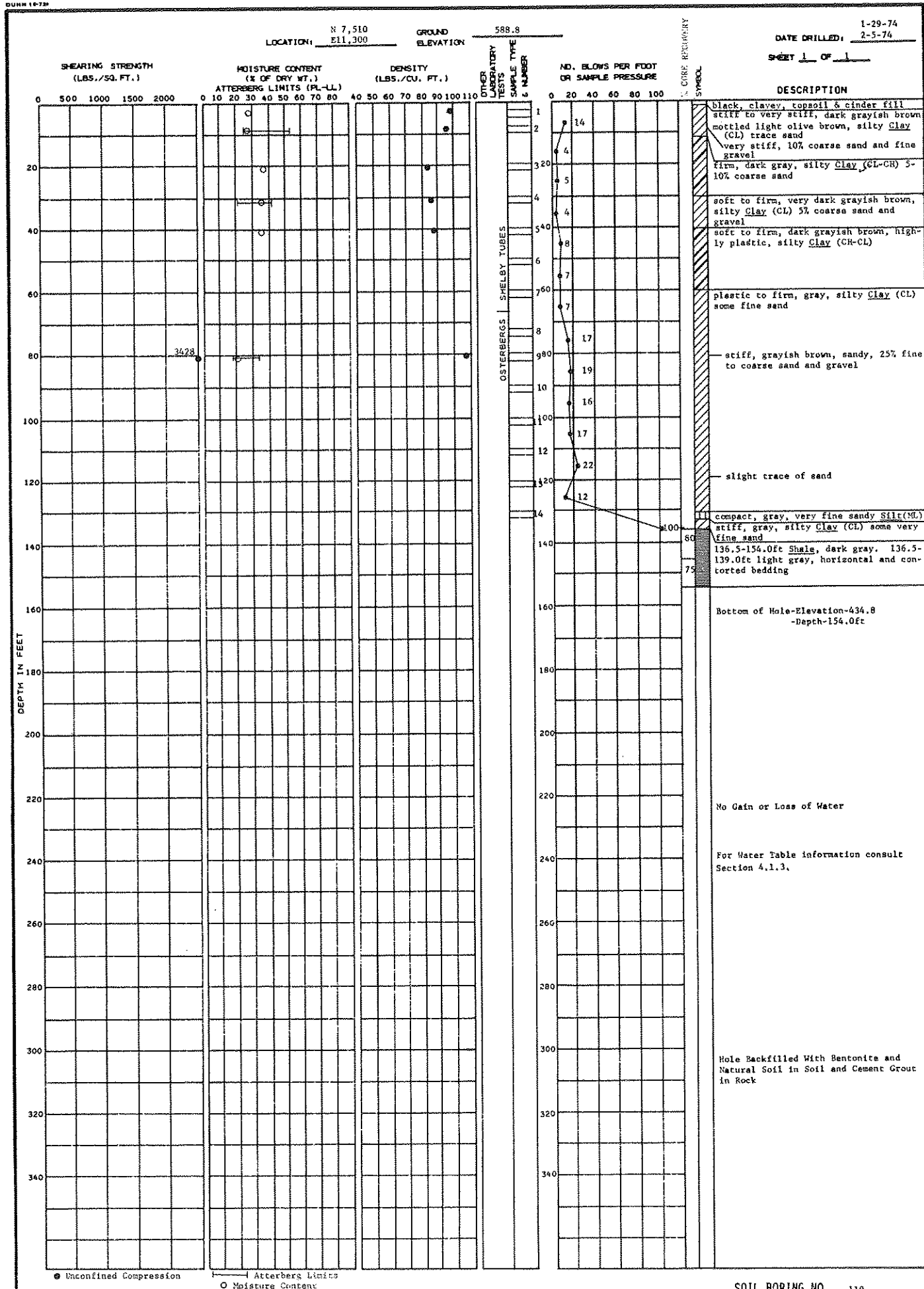
 DATE DRILLED: 2-5-74
2-12-74

SHEET 1 OF 1



SOIL BORING NO. 117

BECHTEL Bella River



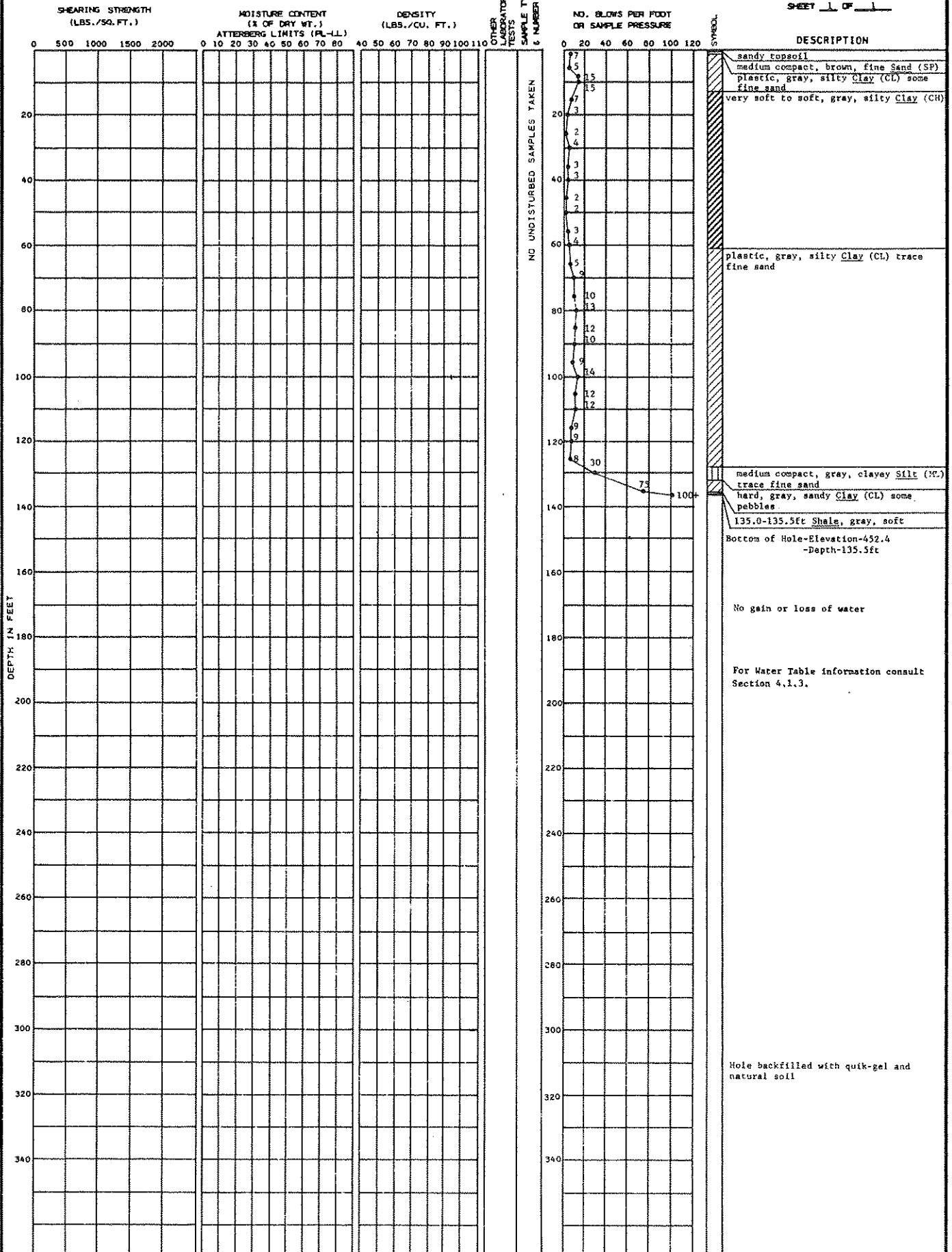
LOCATION: N 7,660
E 10,630

GROUND
ELEVATION

587.9

DATE DRILLED: 2-14-74
2-19-74

SHEET 1 OF 1



SOIL BORING NO. 121

BECHTEL Belle River

LOCATION: N 8,017 E 4,999		GROUND ELEVATION: 588.9		DATE DRILLED: 3-25-74	
SHEARING STRENGTH (LBS./SQ. FT.)		MOISTURE CONTENT (% OF DRY WT.) ATTERBERG LIMITS (PL-LL)		DENSITY (LBS./CU. FT.)	
0 500 1000 1500 2000		0 10 20 30 40 50 60 70 80		40 50 60 70 80 90 100 110	
DEPTH IN FEET		NO. BLOWS PER FOOT OR SAMPLE PRESSURE		DESCRIPTION	
0 20 40 60 80 100 120		0 20 40 60 80 100 120			
0			11		Gray, silty topsoil
10			15		Medium, mottled brown & gray, silty
20			20		sandy clay (CL), trace of pebbles
30			7		Soft, gray, silty clay (CH), trace
40			7		of sand
50			6		
60			5		
70			4		
80			4		
90			4		
100			4		
110			5		
120			6		
130			7		
140			7		
150					
160					
170					
180					
190					
200					
210					
220					
230					
240					
250					
260					
270					
280					
290					
300					
310					
320					
330					
340					

Bottom of hole - Elevation - 518.9
- Depth - 70.0 ft

No gain or loss of water

For Water Table information consult
Section 4.1.3.

Hole backfilled with Quik-Gel and
natural soil

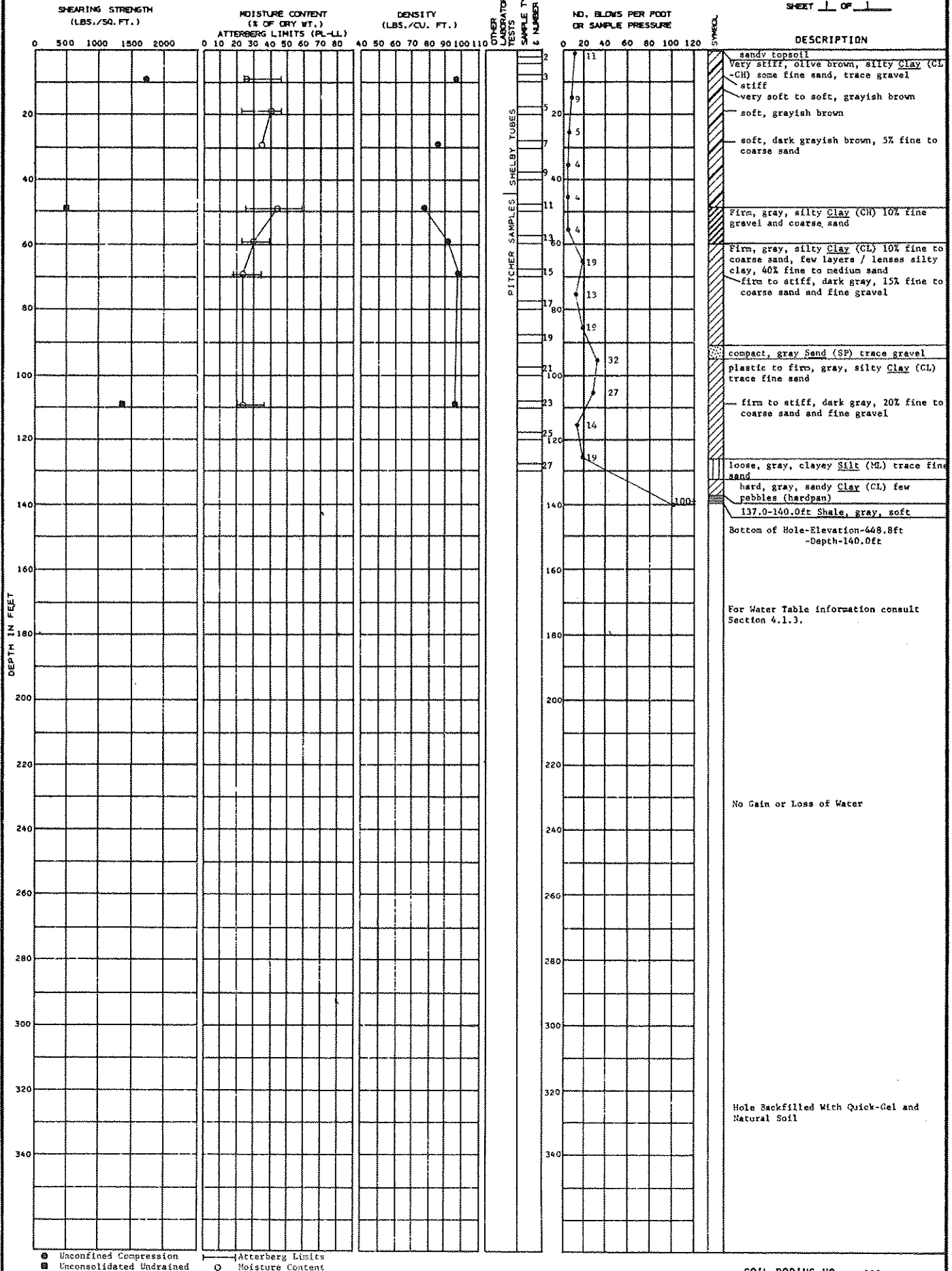
LOCATION: N 7,950
E 11,140

GROUND
ELEVATION

588.8

DATE DRILLED: 2-1-74
2-6-74

SHEET 1 OF 1



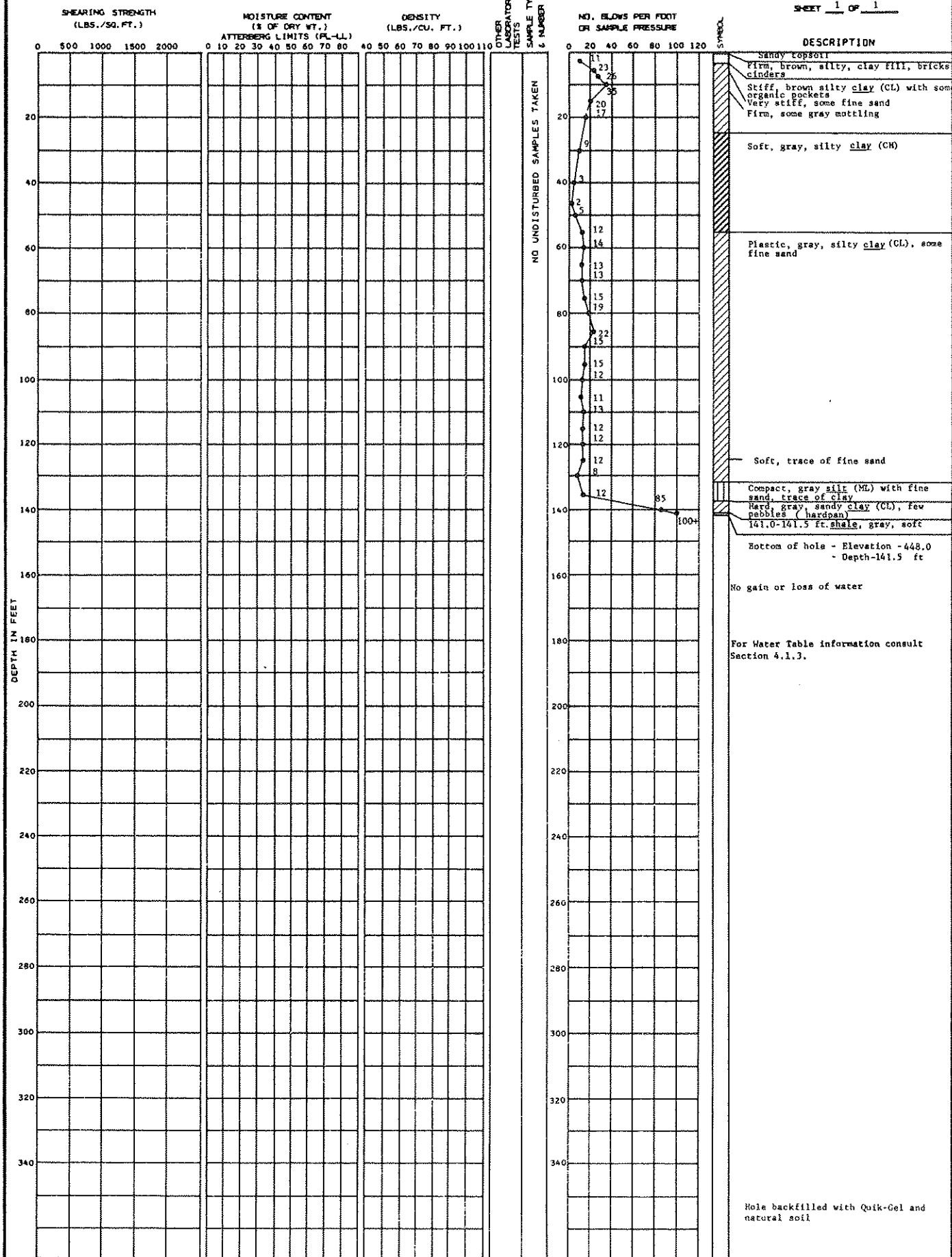
LOCATION: N 3,000
E 11,000

GROUND
ELEVATION

589.5

DATE DRILLED: 2-7-74
2-13-74

SHEET 1 OF 1

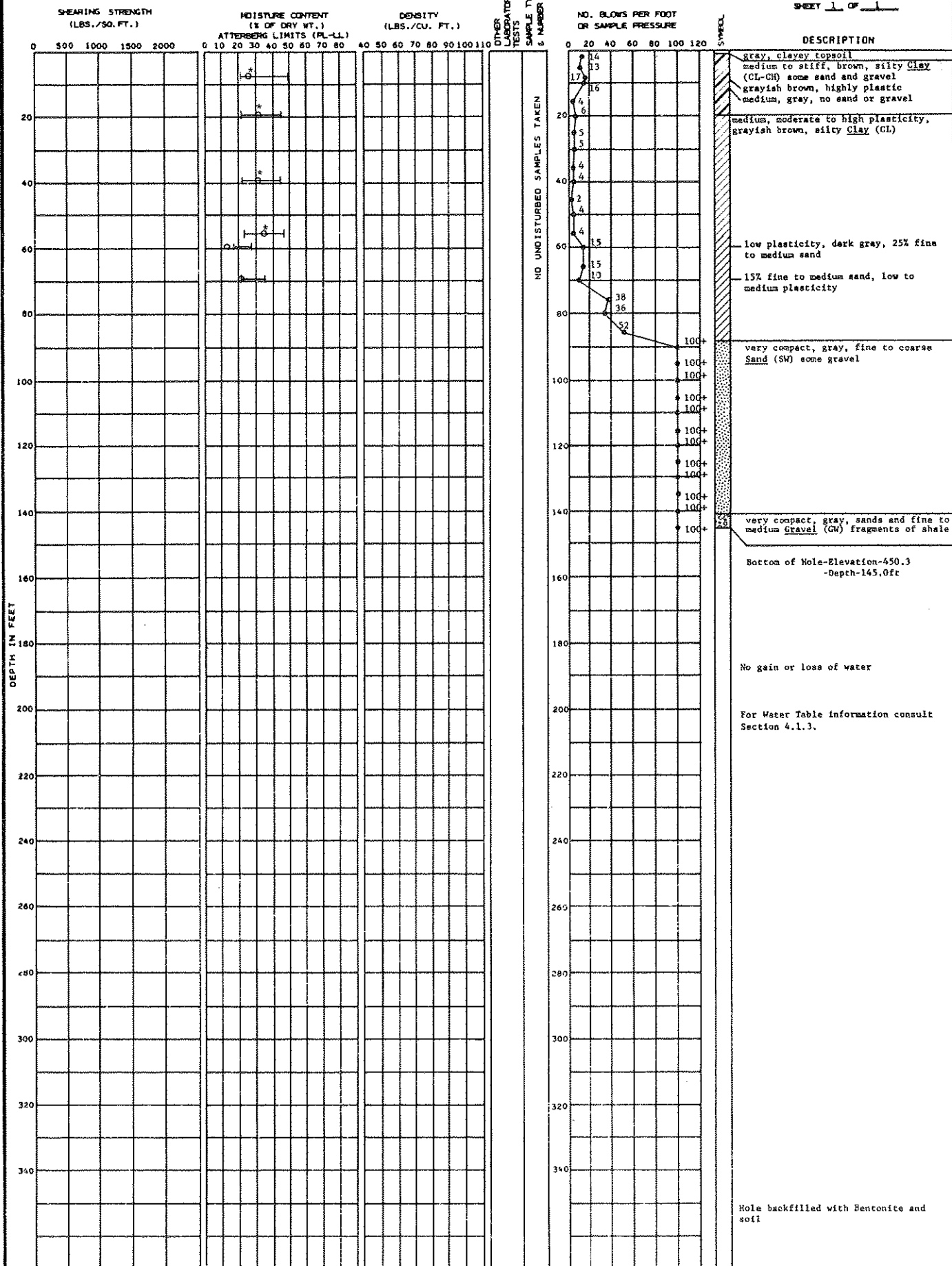


SOIL BORING NO. 128

BECHTEL Belle River

DATE DRILLED: 3-28-74

SHEET 1 OF 1



○ Water Content
 ─── Atterburg Limits
 * Water content taken from unsealed jar sample.

SOIL BORING NO. 130

BECHTEL Delta River

B-95

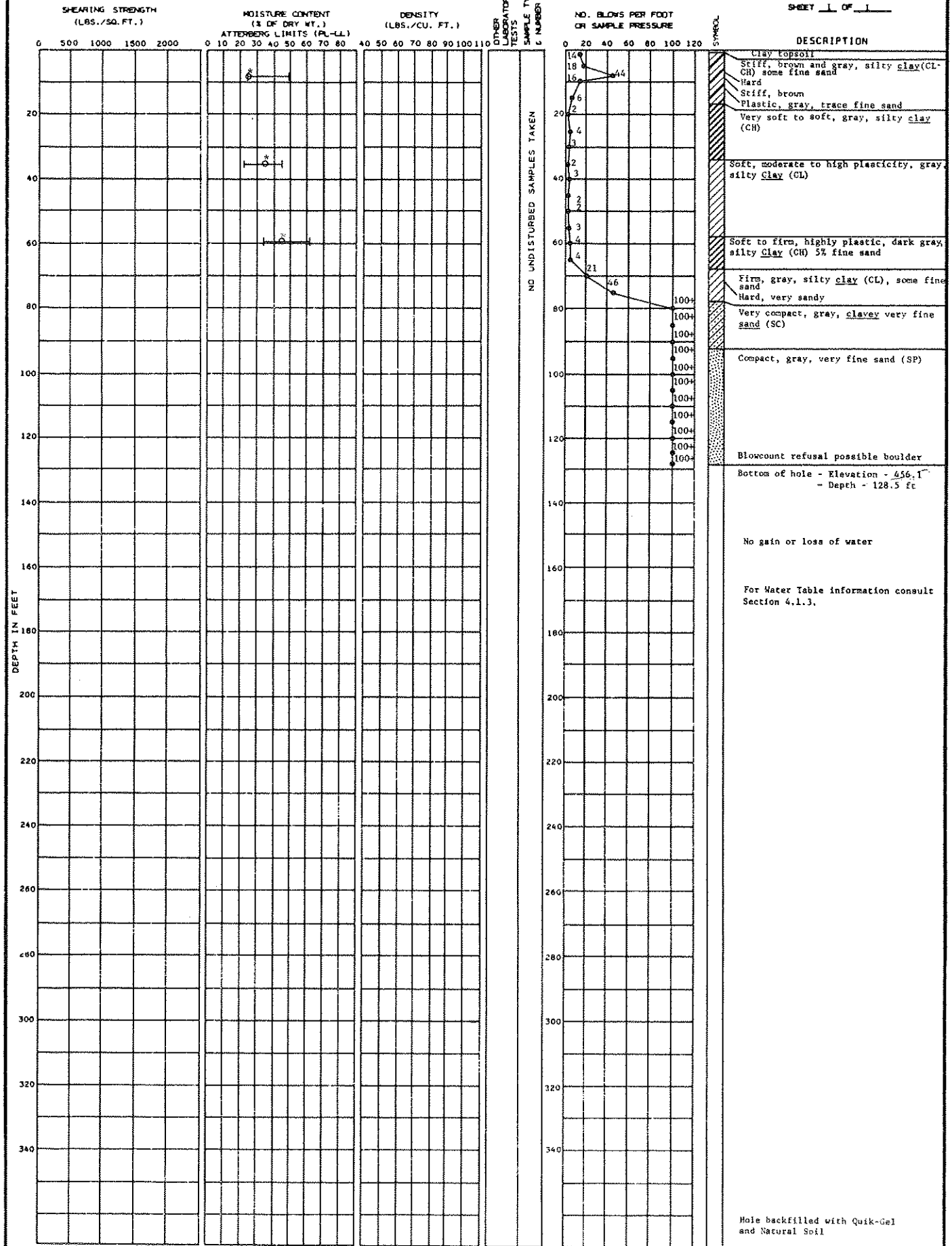
LOCATION: N 10,050
E 4,995

GROUND
ELEVATION

594.6

DATE DRILLED: 3-5-74
3-7-74

SHEET 1 OF 1



○ Water Content
— Atterburg Limits
* Water content taken from unsealed jar sample.

SOIL BORING NO. 134
BECHTEL Belle River



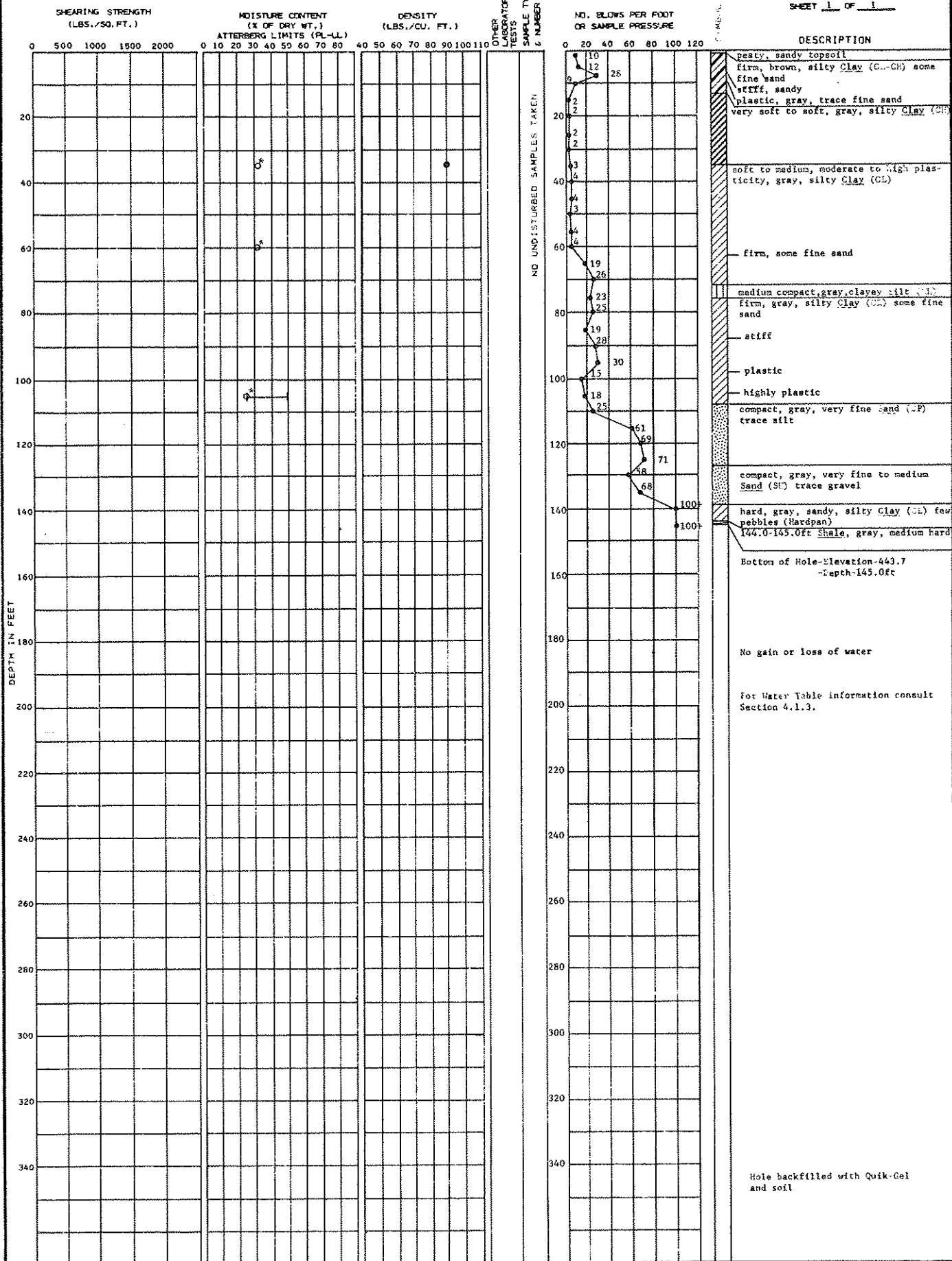
LOCATION: 10,030
S.977

GROUND
ELEVATION

588.7

DATE DRILLED: 3-11-74
3-14-74

SHEET 1 OF 1



Water Content
Atterburg Limits
Water content taken from
unsealed jar sample.

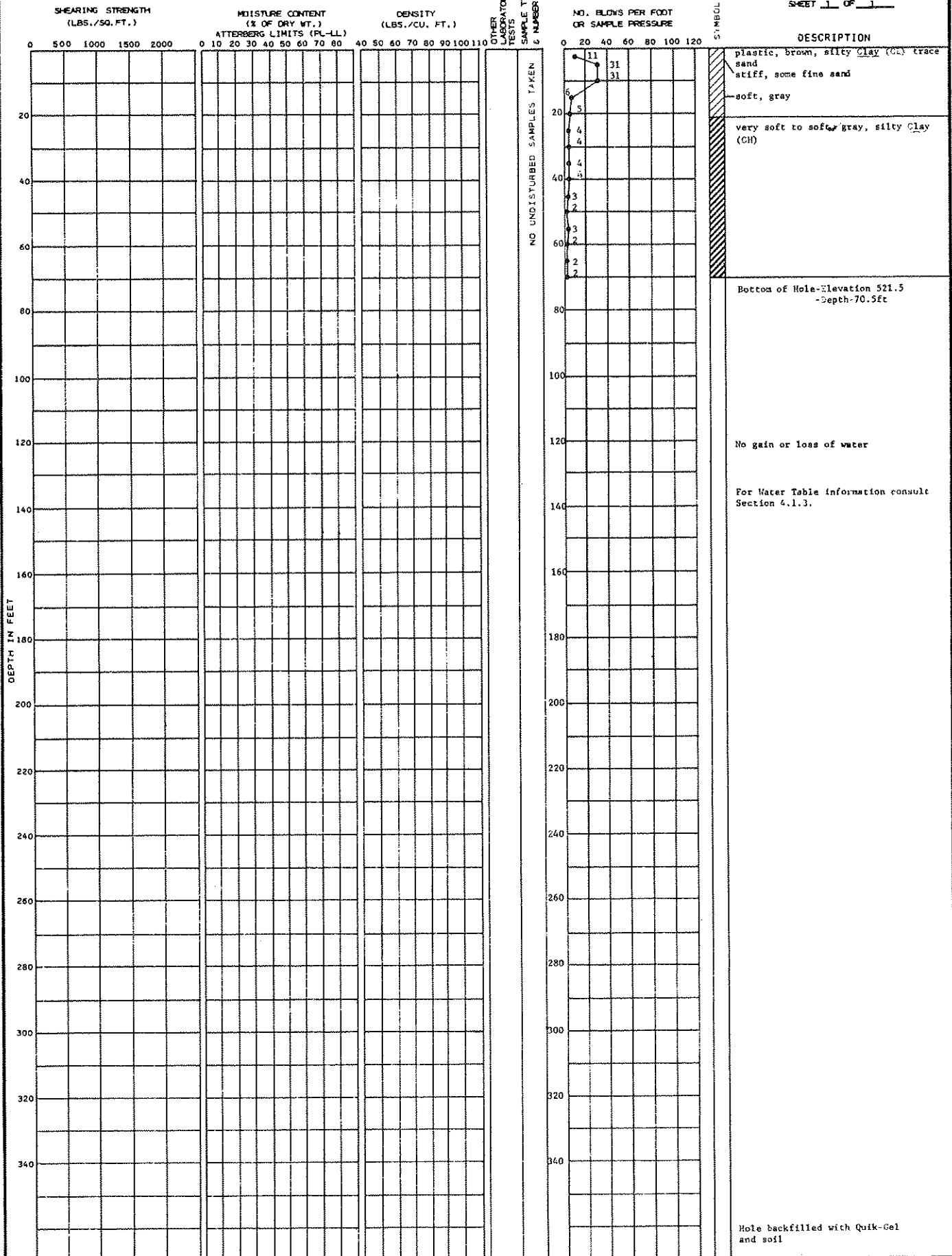
SOIL BORING NO. 138

BECHTEL Belle River

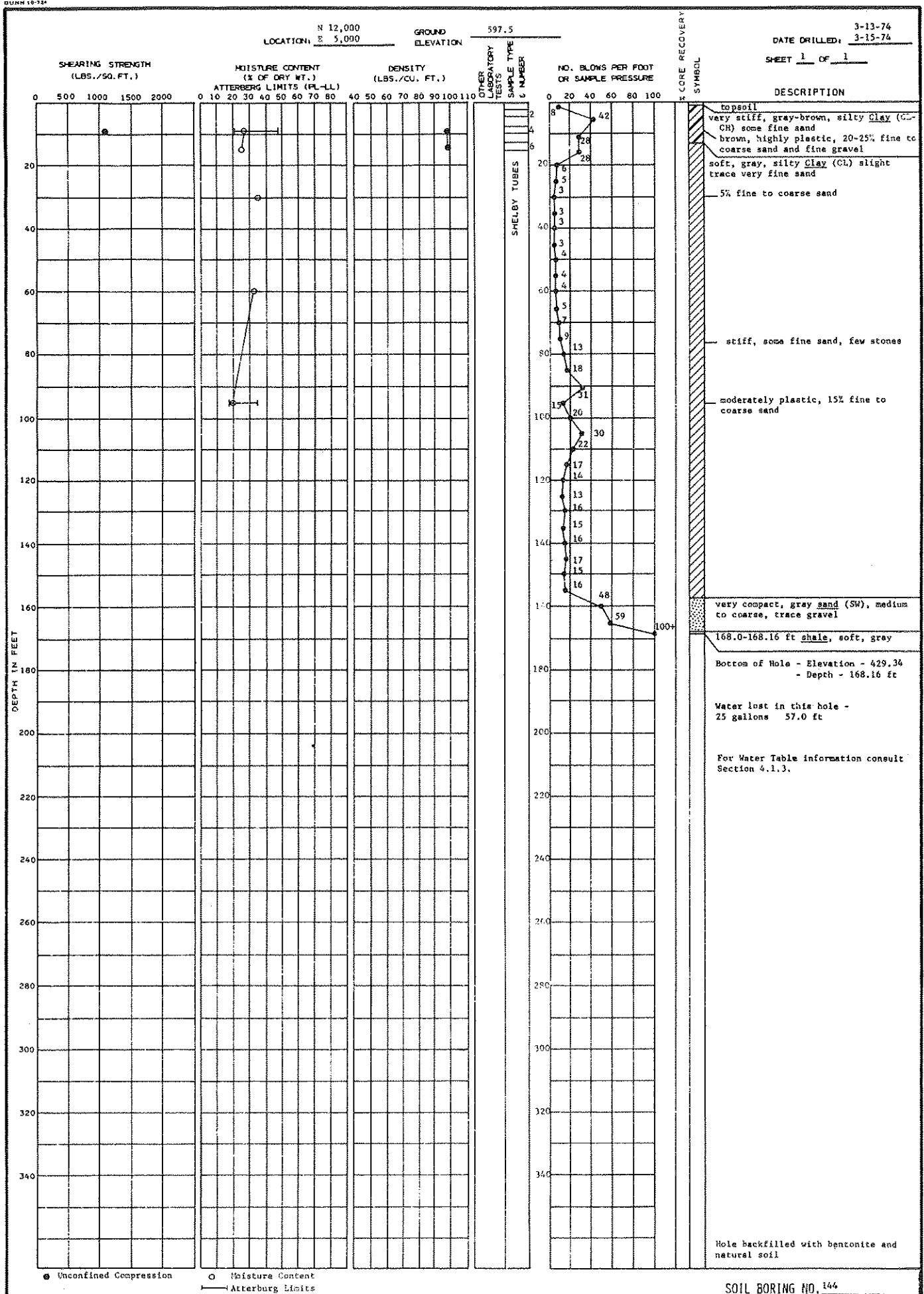
LOCATION: 10,850 GROUND ELEVATION: 592.0

DATE DRILLED: 3-19-74
3-20-74

SHEET 1 OF 1





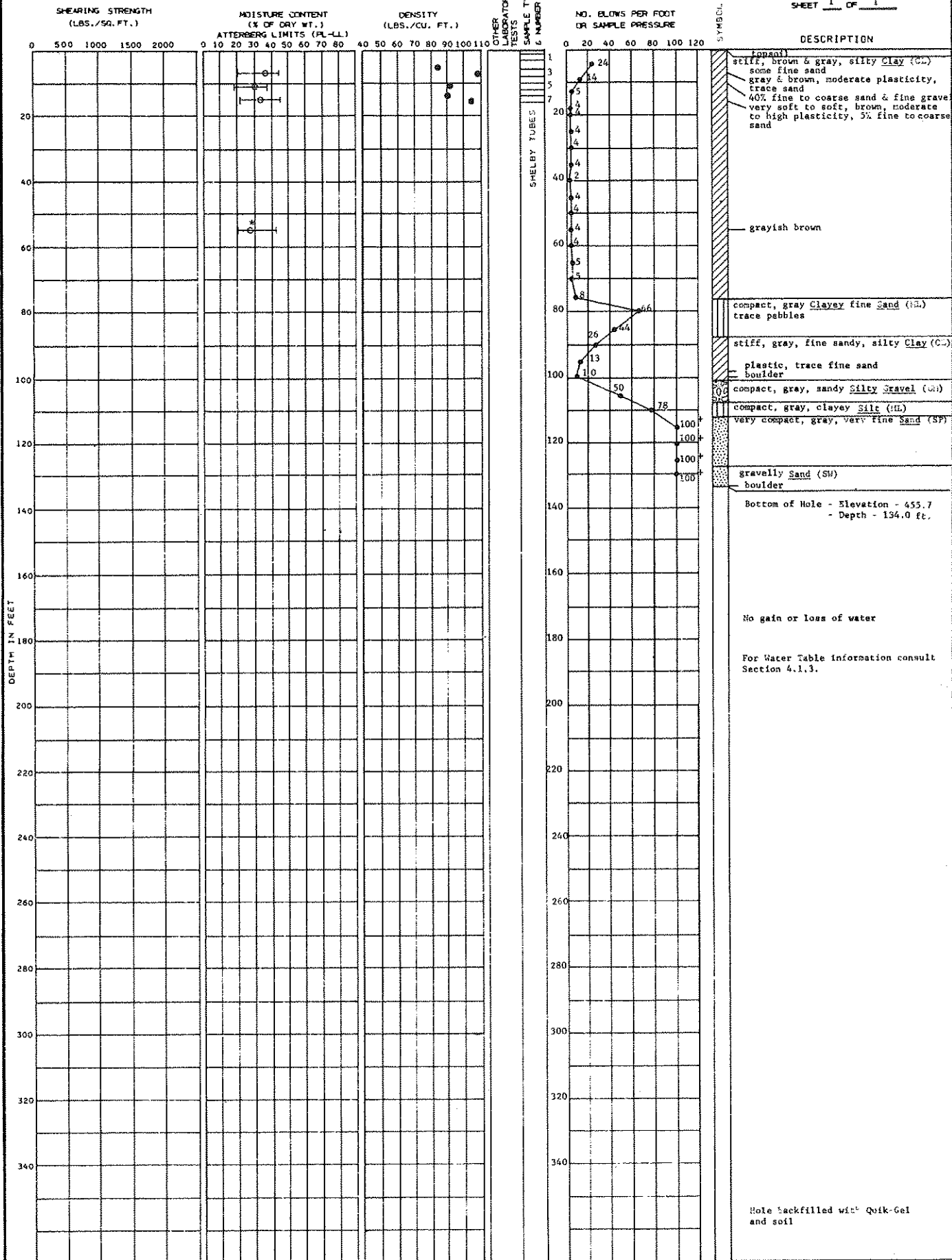


LOCATION: N 12,000
E 7,000

GROUND ELEVATION 589.7

3-18-74
DATE DRILLED: 3-19-74

SHEET 1 OF 1



LOCATION: N 13,061
E 5,006

GROUND
ELEVATION

598.6

DATE DRILLED: 3-28-74

SHEET 1 OF 1

DEPTH IN FEET	SHEARING STRENGTH (LBS./SQ. FT.)	MOISTURE CONTENT (% OF DRY WT.) ATTERBERG LIMITS (PL-LL)	DENSITY (LBS./CU. FT.)	OTHER LABORATORY TESTS	SAMPLE TYPE C NUMBER	NO. BLOWS PER FOOT OR SAMPLE PRESSURE	SYMBOL	DESCRIPTION
0	500 1000 1500 2000	0 10 20 30 40 50 60 70 80	40 50 60 70 80 90 100 110			0 20 40 60 80 100 120		Black, clayey topsoil
20								Firm, brown & gray, silty, sandy clay (CL), trace of pebbles
40								Soft, gray, silty clay (CH), trace of sand
60								
80								
100								Bottom of hole - Elevation - 528.6 - Depth - 70.0 ft
120								No gain or loss of water
140								For Water Table information consult Section 4.1.3.
160								
180								
200								
220								
240								
260								
280								
300								
320								
340								Hole backfilled with Quik-Gel and natural soil

SOIL BORING NO. 148

BECHTEL Belle River

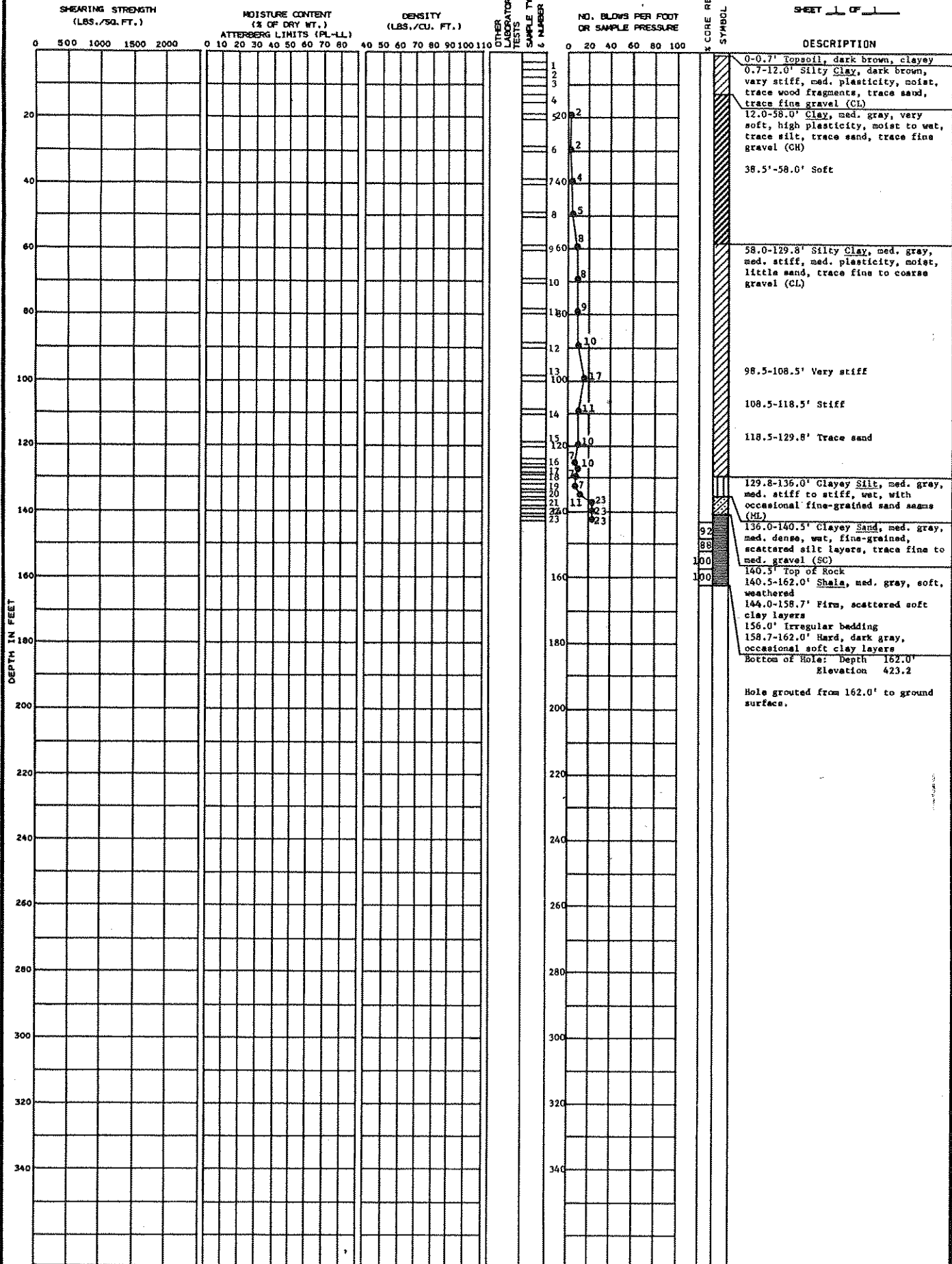
LOCATION: N 7455
E 9535

 GROUND
ELEVATION

585.2

 DATE DRILLED: 9/28/77
9/30/77

SHEET 1 OF 1



SOIL BORING NO. B-8

BECHTEL Belle River

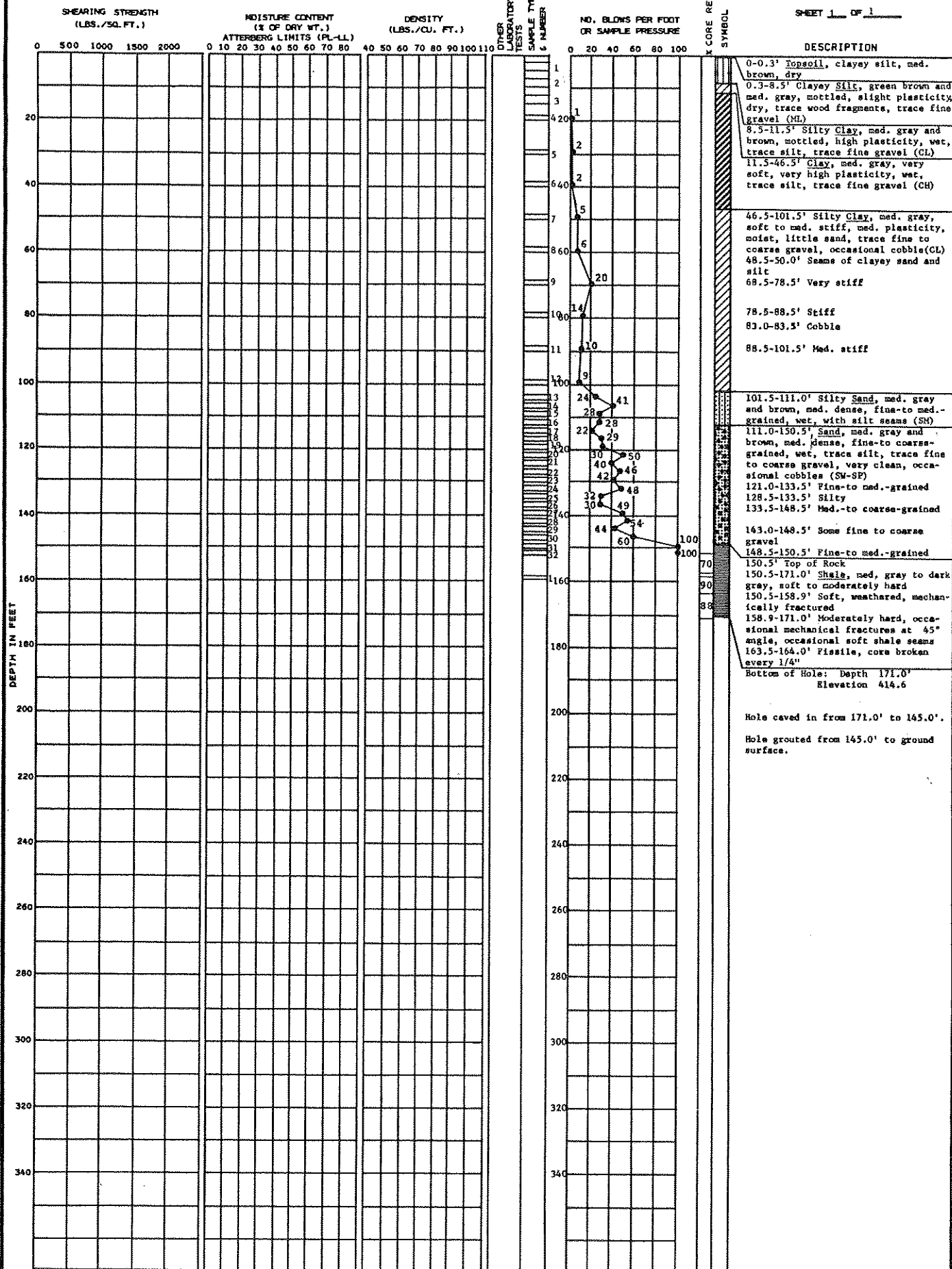
LOCATION: N 7675
E 9100

GROUND
ELEVATION

585.6

DATE DRILLED: 8/8/77
8/11/77

SHEET 1 OF 1

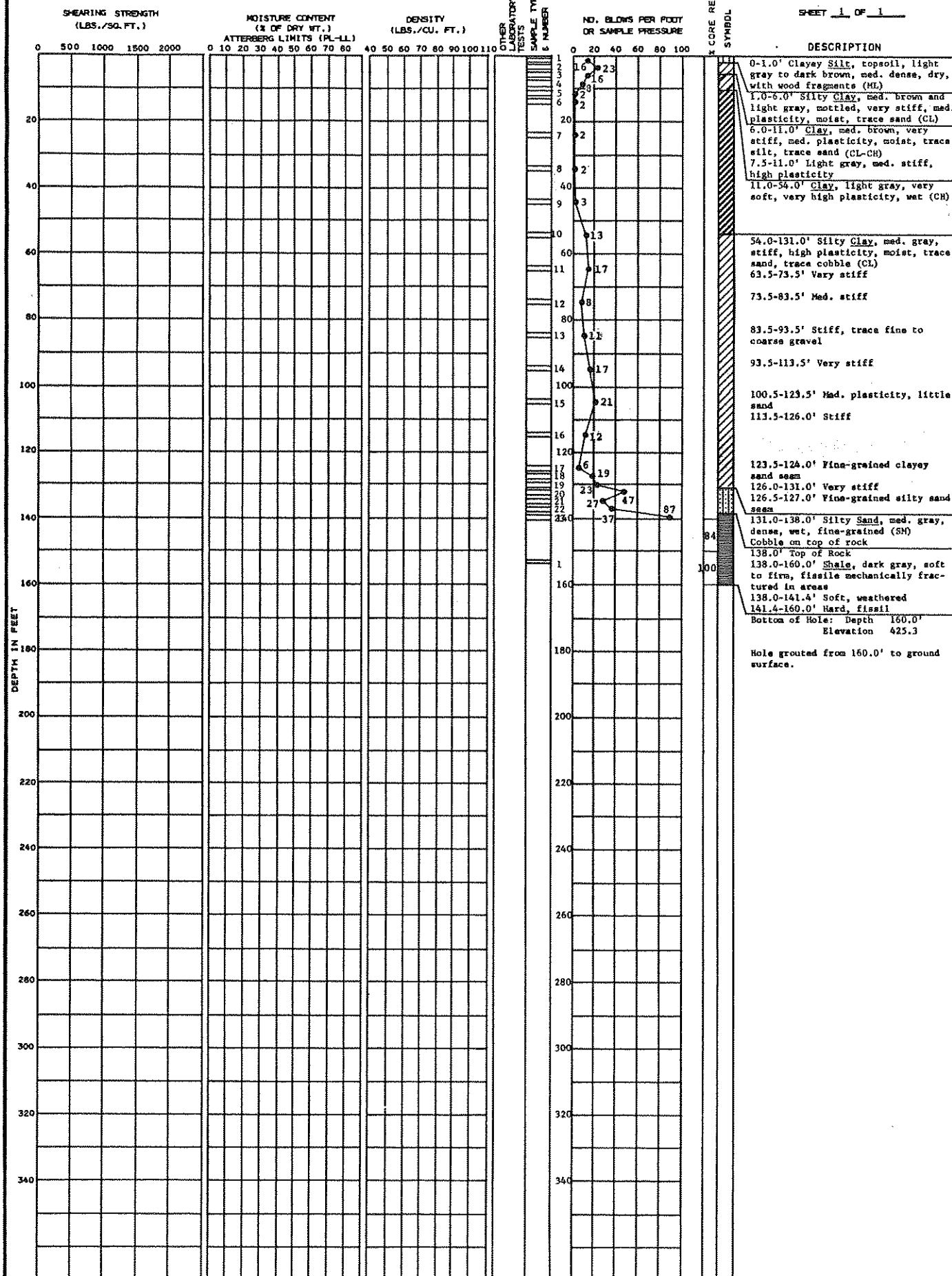


SOIL BORING NO. B-9

BECHTEL Belle River

LOCATION: N 7500 E 9388.7 GROUND ELEVATION 585.3

DATE DRILLED: 7/21/77
7/25/77
SHEET 1 OF 1



SOIL BORING NO. B-12

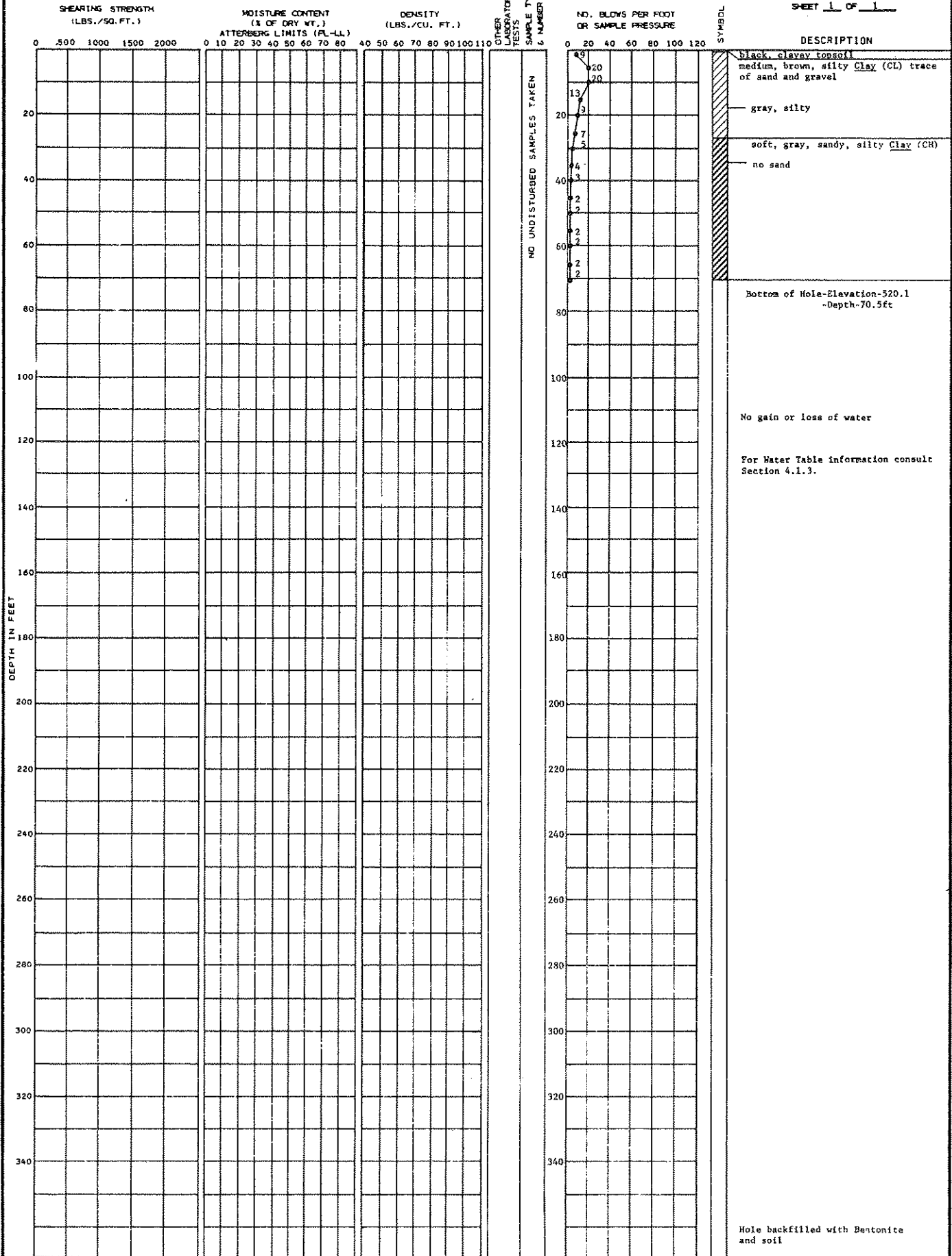
BECHTEL/Bella River

LOCATION: N 13,000
E 7,000

GROUND ELEVATION 590.6

DATE DRILLED: 3-27-74
3-28-74

SHEET 1 OF 1

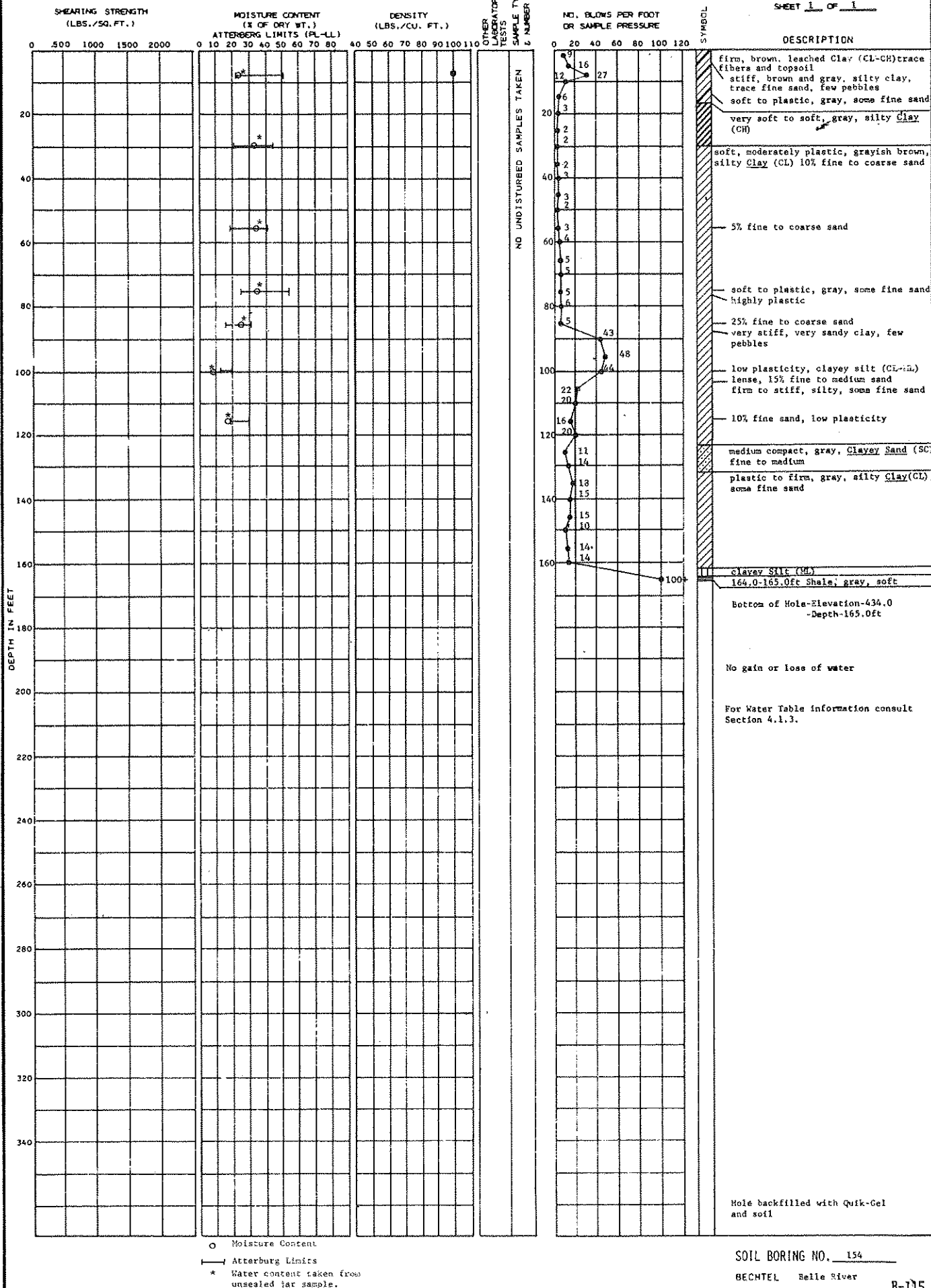


SOIL BORING NO. 150

BECHTEL Belle River

DATE DRILLED: 3-7-74
3-14-74

SHEET 1 OF 1



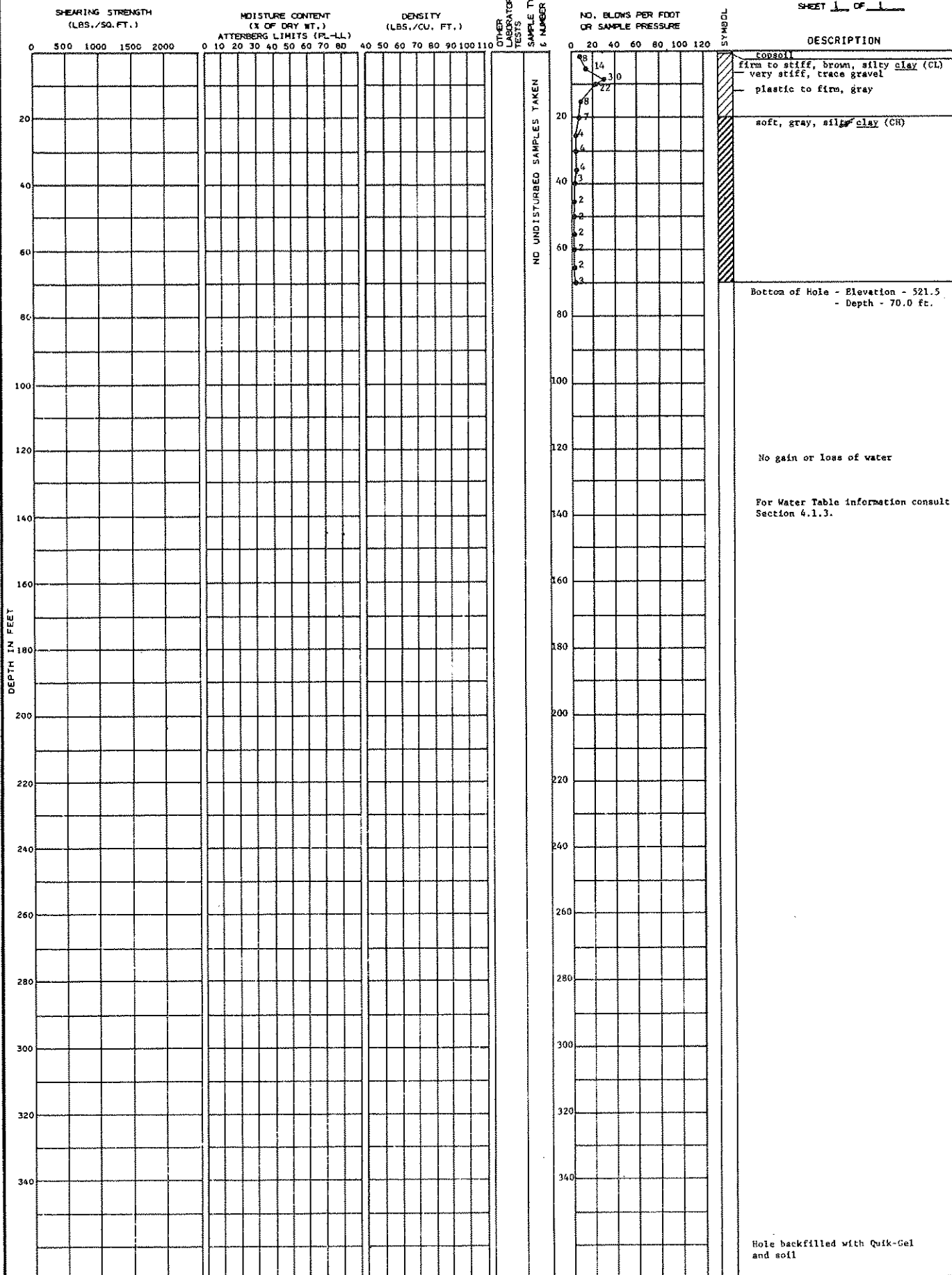
SOIL BORING NO. 154

BECHTEL Belle River

B-115

DATE DRILLED: 4-5-74

SHEET 1 OF 1



SOIL BORING NO. 157

BECHTEL Belle River

LOCATION: N 14,000 E 9,950		GROUND ELEVATION 591.3		DATE DRILLED: 4-3-74	
SHEARING STRENGTH (LBS./SQ. FT.)		MOISTURE CONTENT (% OF DRY WT.) ATTERBERG LIMITS (PL-LL)		DENSITY (LBS./CU. FT.)	
0 500 1000 1500 2000		0 10 20 30 40 50 60 70 80		40 50 60 70 80 90 100 110	
DEPTH IN FEET		NO. BLOWS PER FOOT OR SAMPLE PRESSURE		SYMBOL	
0 20 40 60 80 100 120		0 20 40 60 80 100 120		DESCRIPTION	
				GRAY SILT (ML)	
				loose to medium compact, brown to gray, silty sand (SM) fine to medium	
				firm, gray, silty clay (CL)	
				soft, gray, silty clay (CH)	
				Bottom of Hole - Elevation - 521.3 - Depth - 70.0 ft.	
				No gain or loss of water	
				For Water Table information consult Section 4.1.3.	
				Hole backfilled with Quik-Gel in soil	

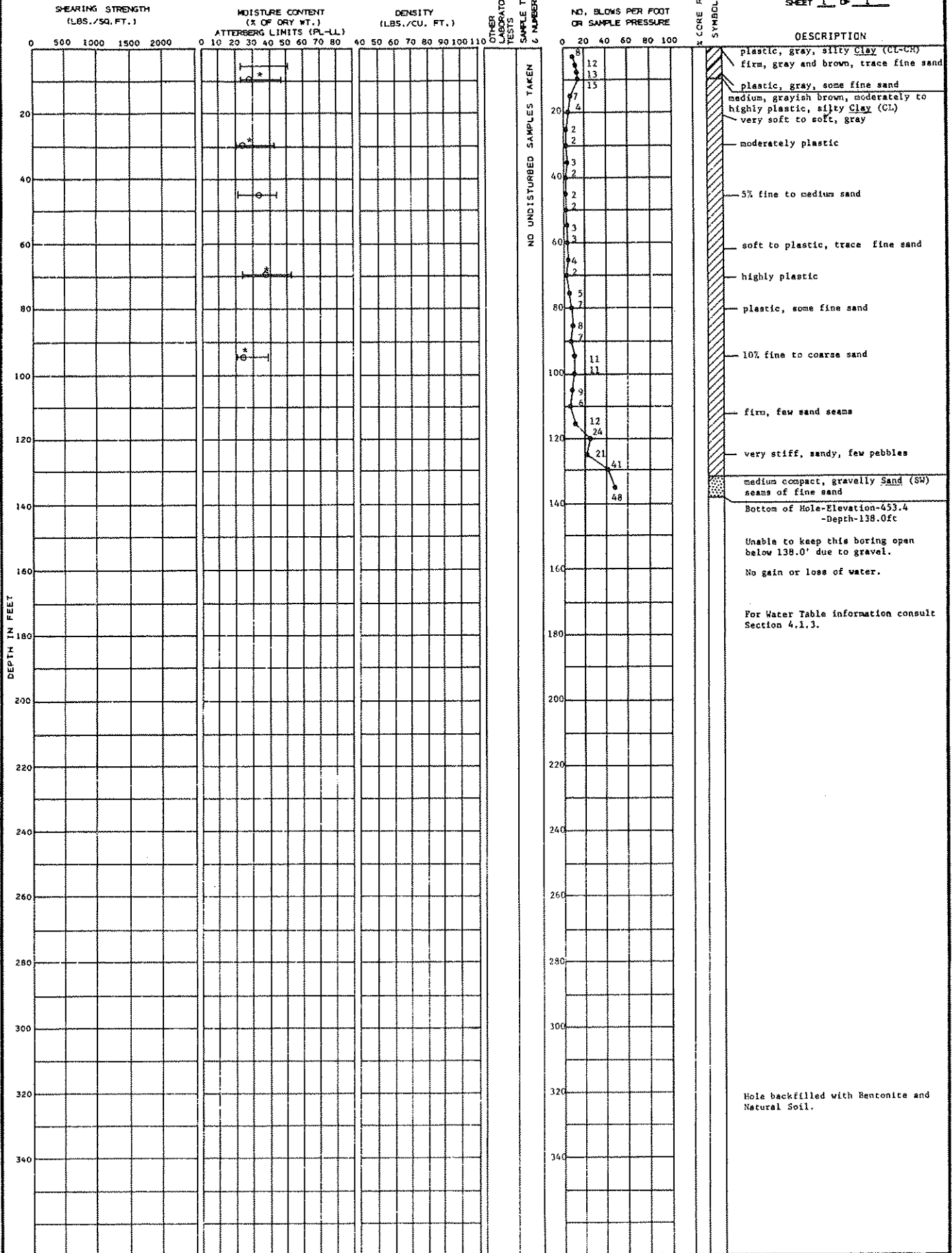
LOCATION: N 15,000
E 8,000

GROUND
ELEVATION

591.4

DATE DRILLED: 4-8-74

SHEET 1 OF 1



SOIL BORING NO. 163

BECHTEL Belle River

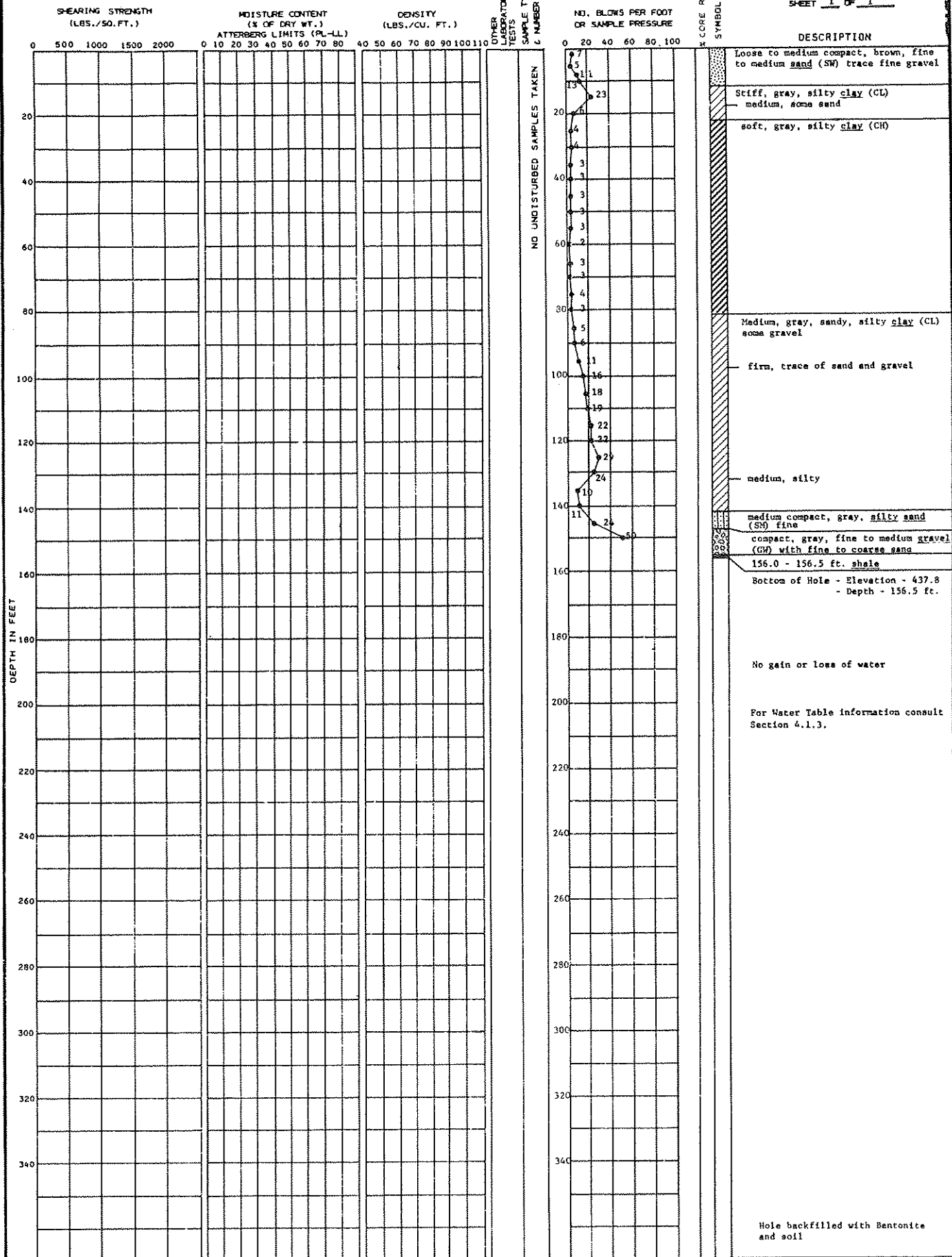
B-121

LOCATION: N 14,830
 E 9,938

GROUND ELEVATION 594.3

 DATE DRILLED: 3-26-74
 3-27-74

SHEET 1 OF 1



SOIL BORING NO. 165

BECHTEL Belle River

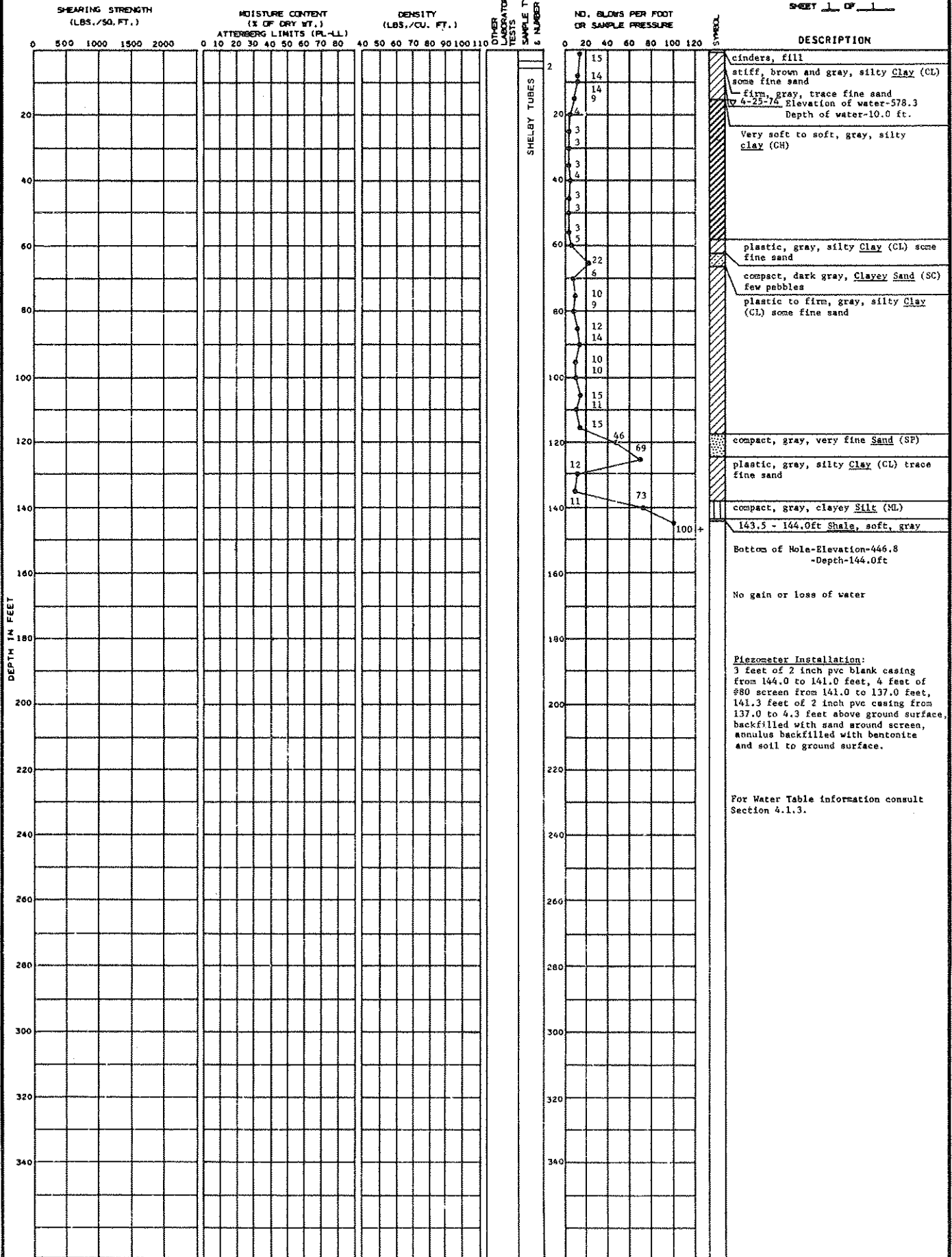
LOCATION: N 3,525
E 12,533

GROUND
ELEVATION

590.8

DATE DRILLED: 3-5-74
3-7-74

SHEET 1 OF 1



SOIL BORING NO. 181

BECHTEL Belle River

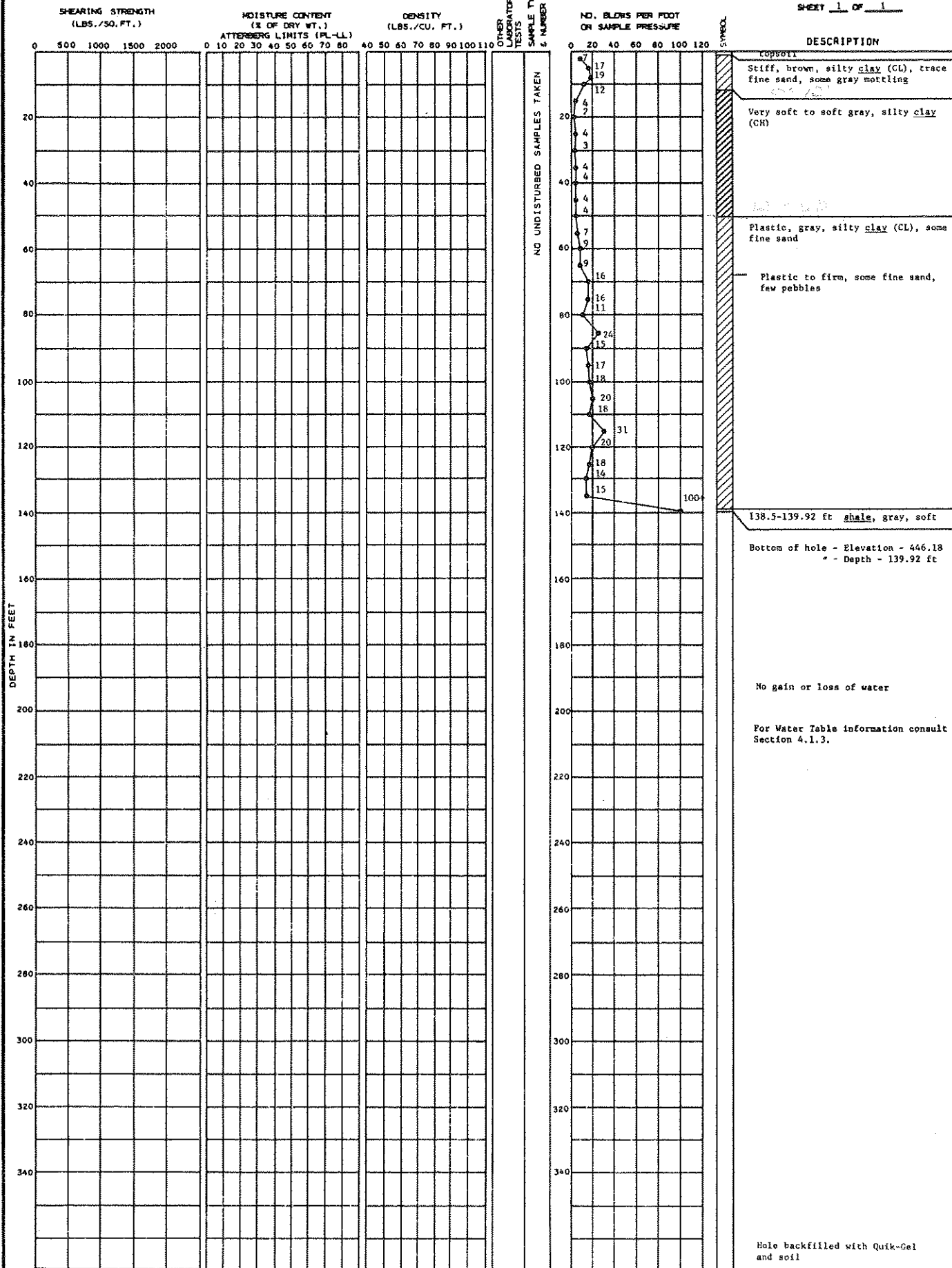
B-125

LOCATION: N 3,556
E 9,564

GROUND ELEVATION 586.1

DATE DRILLED: 3-15-74
3-19-74

SHEET 1 OF 1



SOIL BORING NO. 184

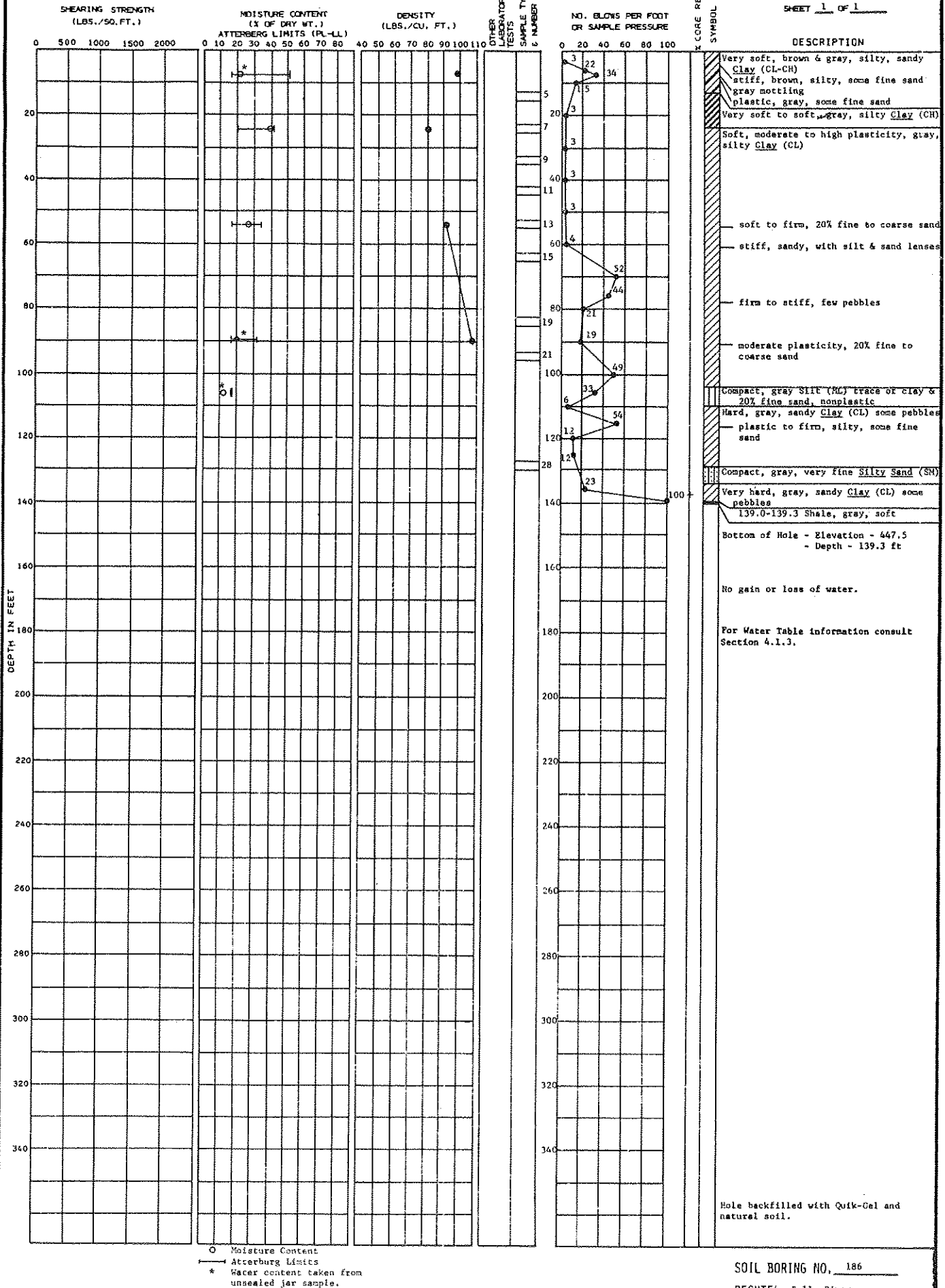
BECHTEL Belle River

LOCATION: N 5,500
E 9,797GROUND
ELEVATION

586.8

DATE DRILLED: 2-26-74
2-27-74

SHEET 1 OF 1

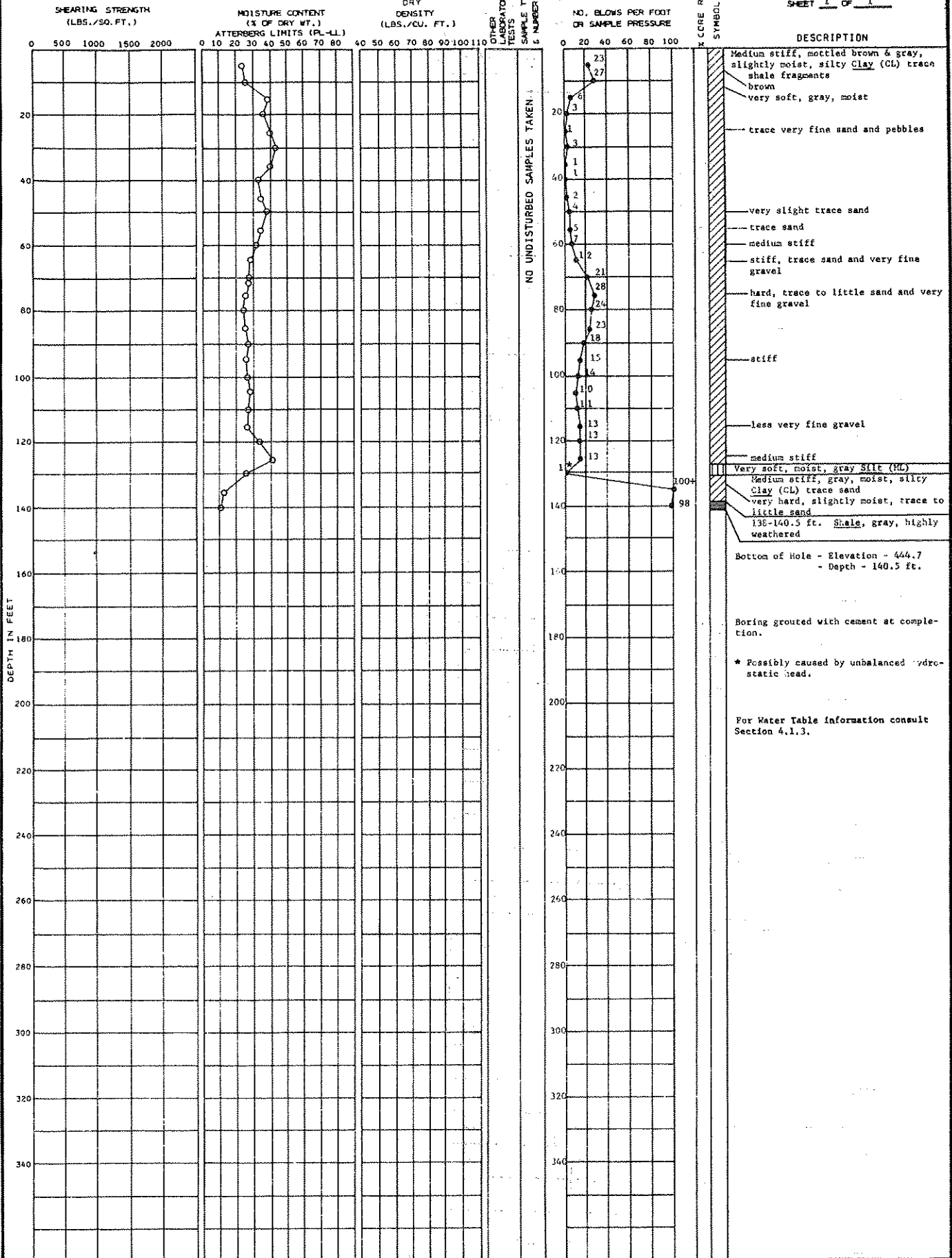


LOCATION: N 3500
E 11741

GROUND ELEVATION: 585.2

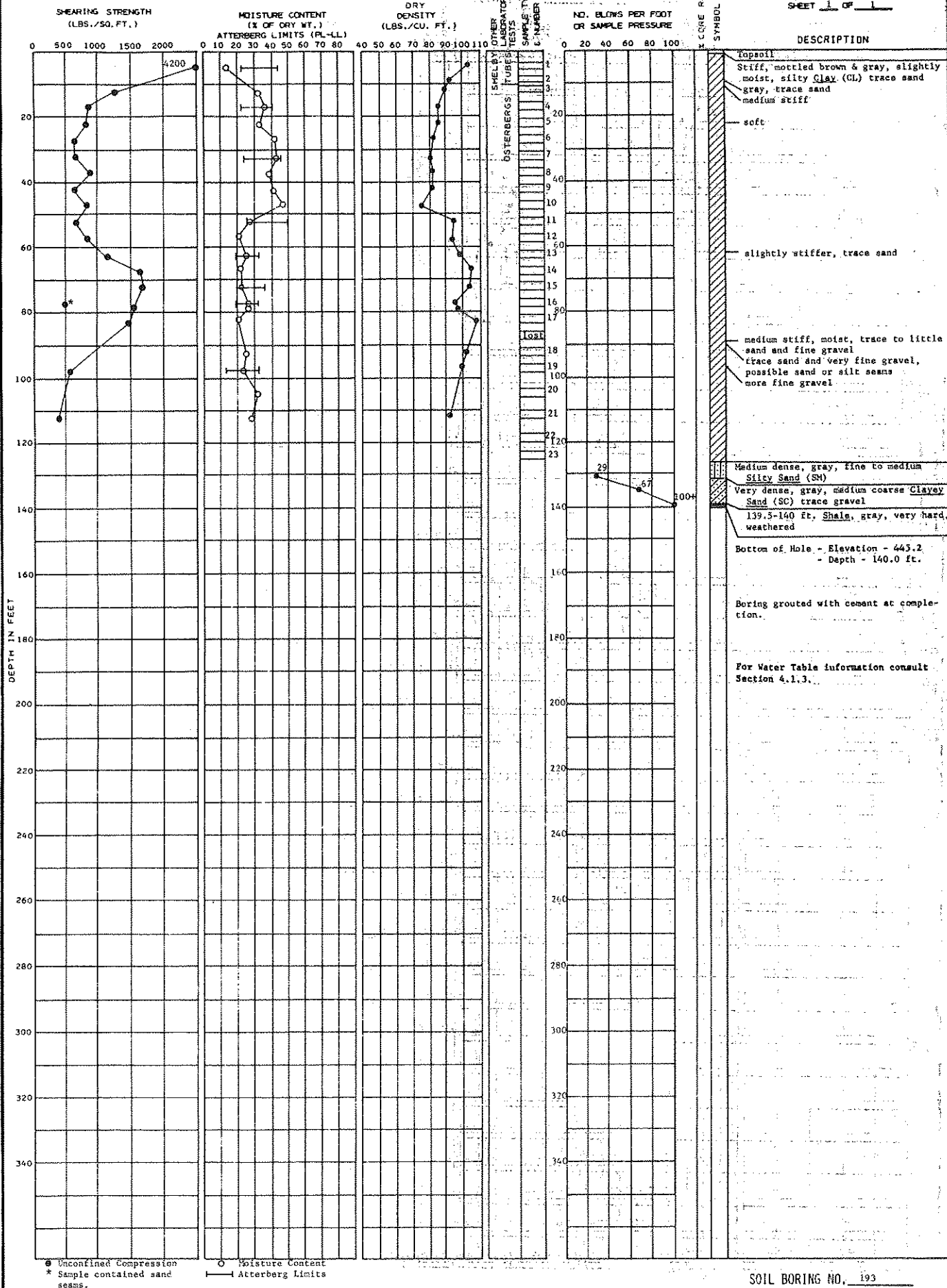
 DATE DRILLED: 8/6/75
8/8/75

SHEET 1 OF 1



DATE DRILLED: 8/14/75

SHEET 1 OF 1



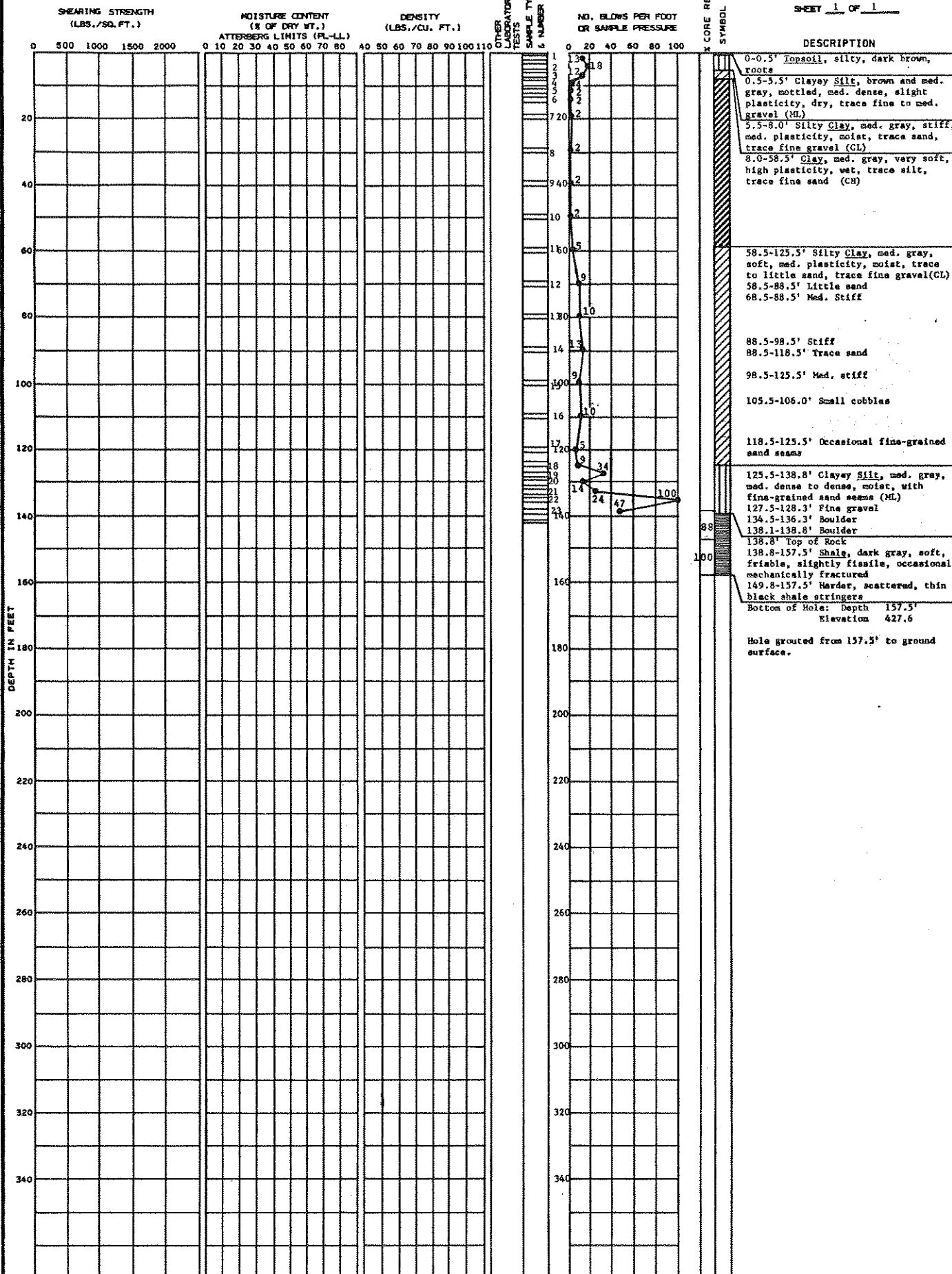
SOIL BORING NO. 193

BECHTEL BELLE RIVER

LOCATION: N 7800 E 9400 GROUND ELEVATION 585.1

DATE DRILLED: 8/17/77 8/22/77

SHEET 1 OF 1

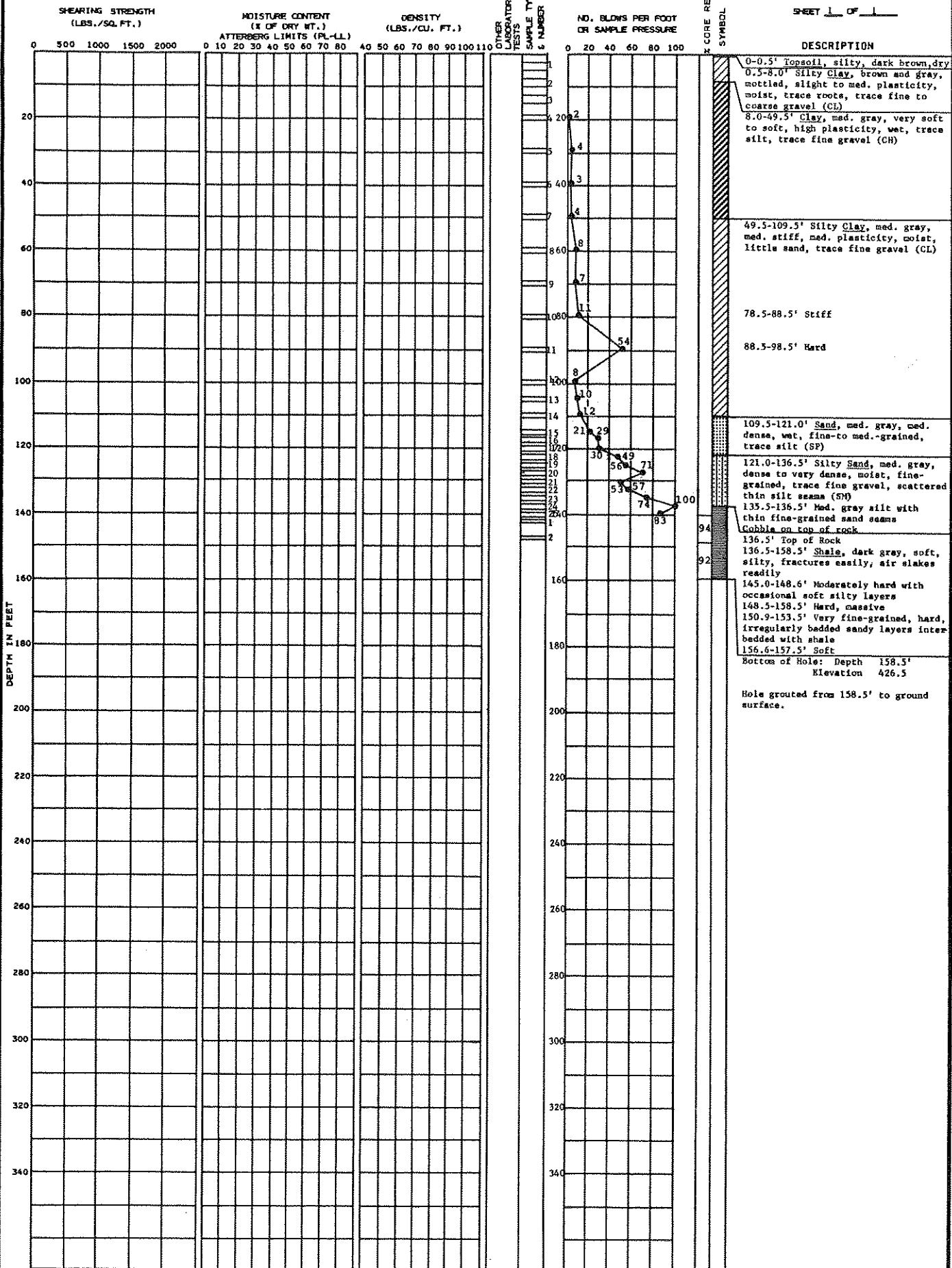


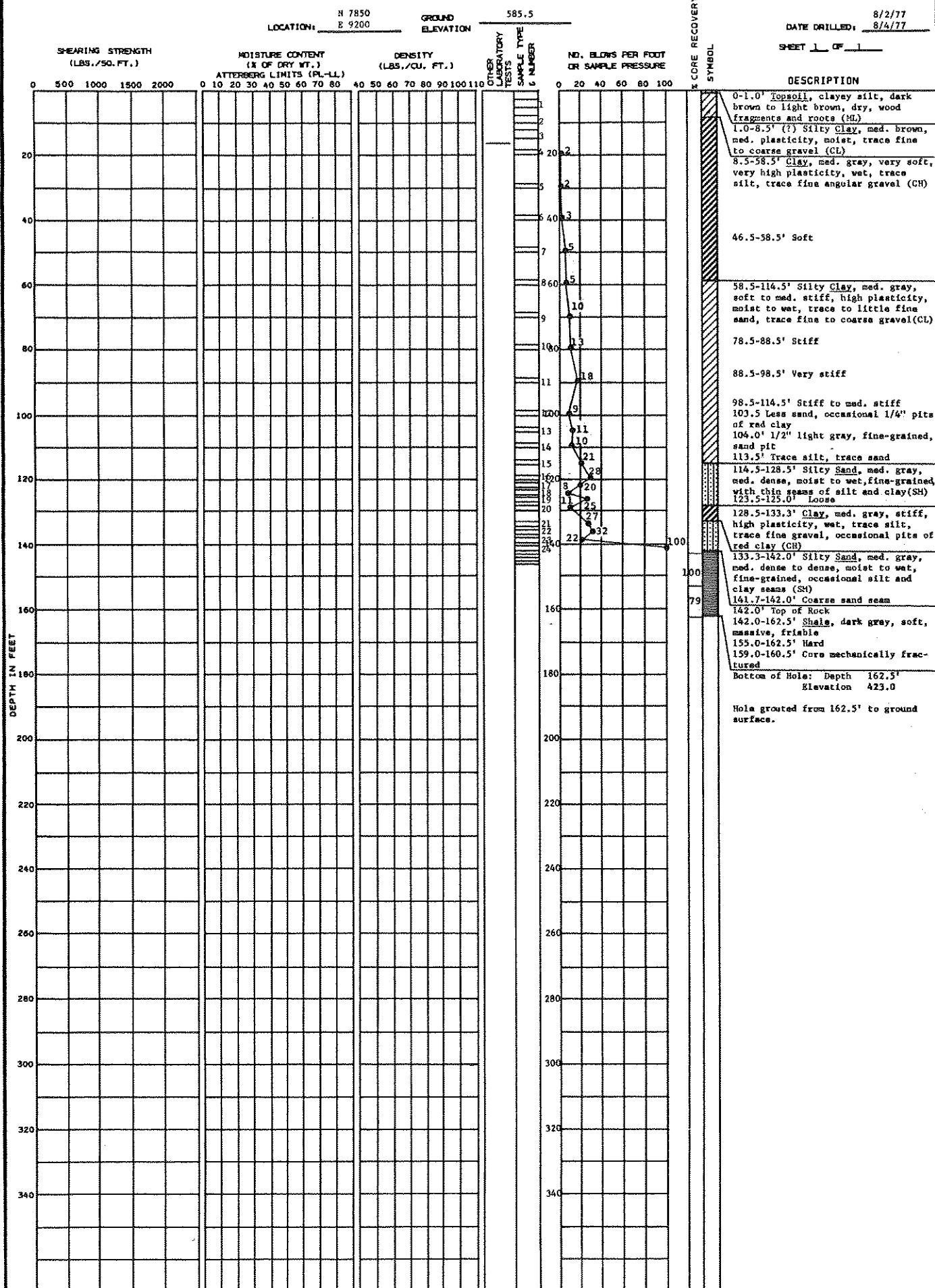
SOIL BORING NO. B-1
BECHTEL Belle River

LOCATION: N 7500 E 9200 GROUND ELEVATION 585.0

DATE DRILLED: 8/23/77 8/25/77

SHEET 1 OF 1

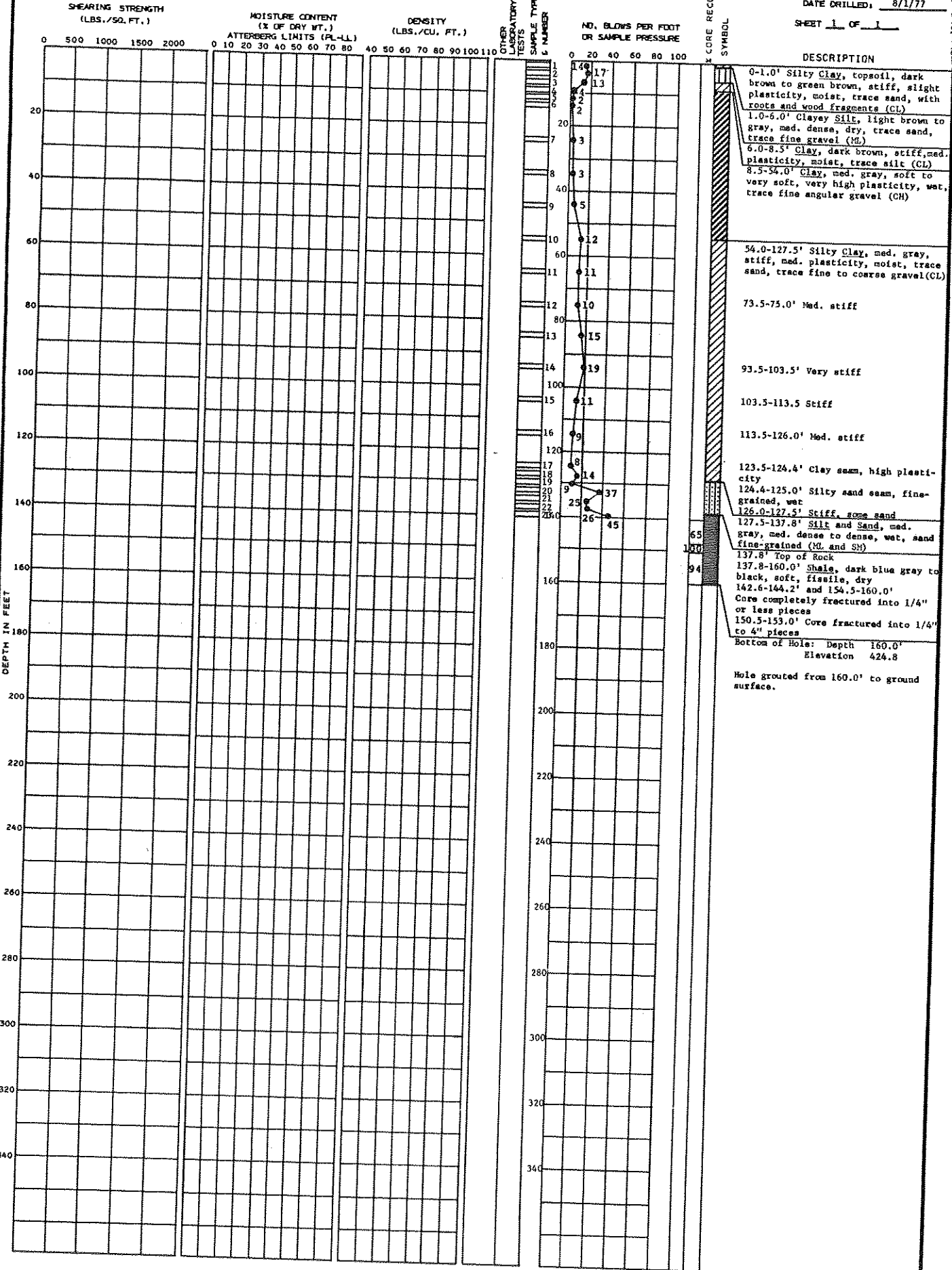




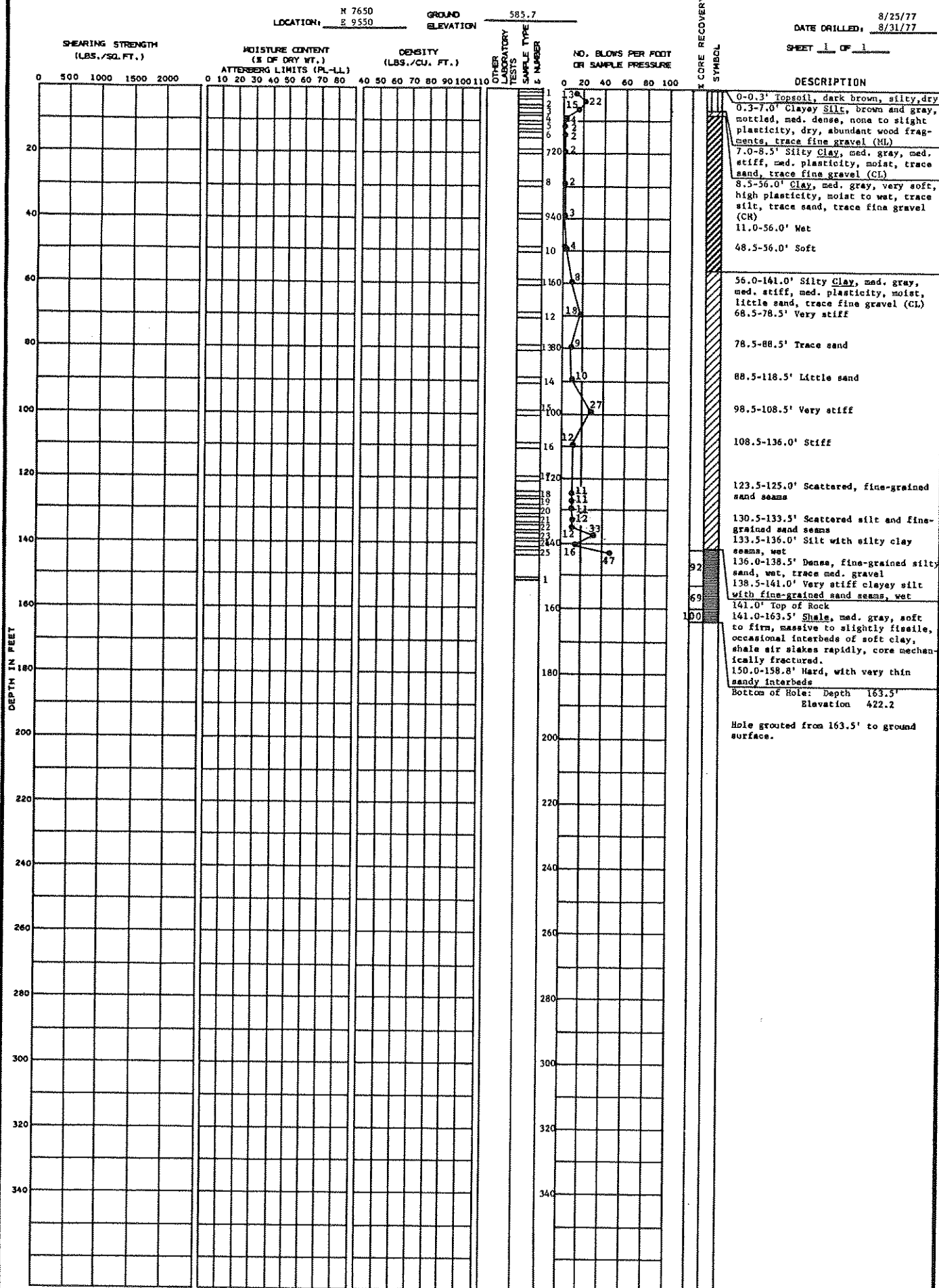
LOCATION: N 7600 E 9400 GROUND ELEVATION 584.8

DATE DRILLED: 7/26/77 8/1/77

SHEET 1 OF 1



SOIL BORING NO. B-5
BECHTEL Belle River



SOIL BORING NO. 8-6

BECHTEL, Belle River

DATE DRILLED: 8/12/77
8/17/77

SHEET 1 OF 1

SHEARING STRENGTH
(LBS./SQ. FT.)

MOISTURE CONTENT
(% OF DRY WT.)
TERBERG LIMITS (PL-LL)

DENSITY
(LBS./CU. FT.)

OTHER LABORATORY TESTS	SAMPLE TYPE & NUMBER

NO. BLOWS PER FOOT
OR SAMPLE PRESSURE

CORE RECOVERY
SYMBOL

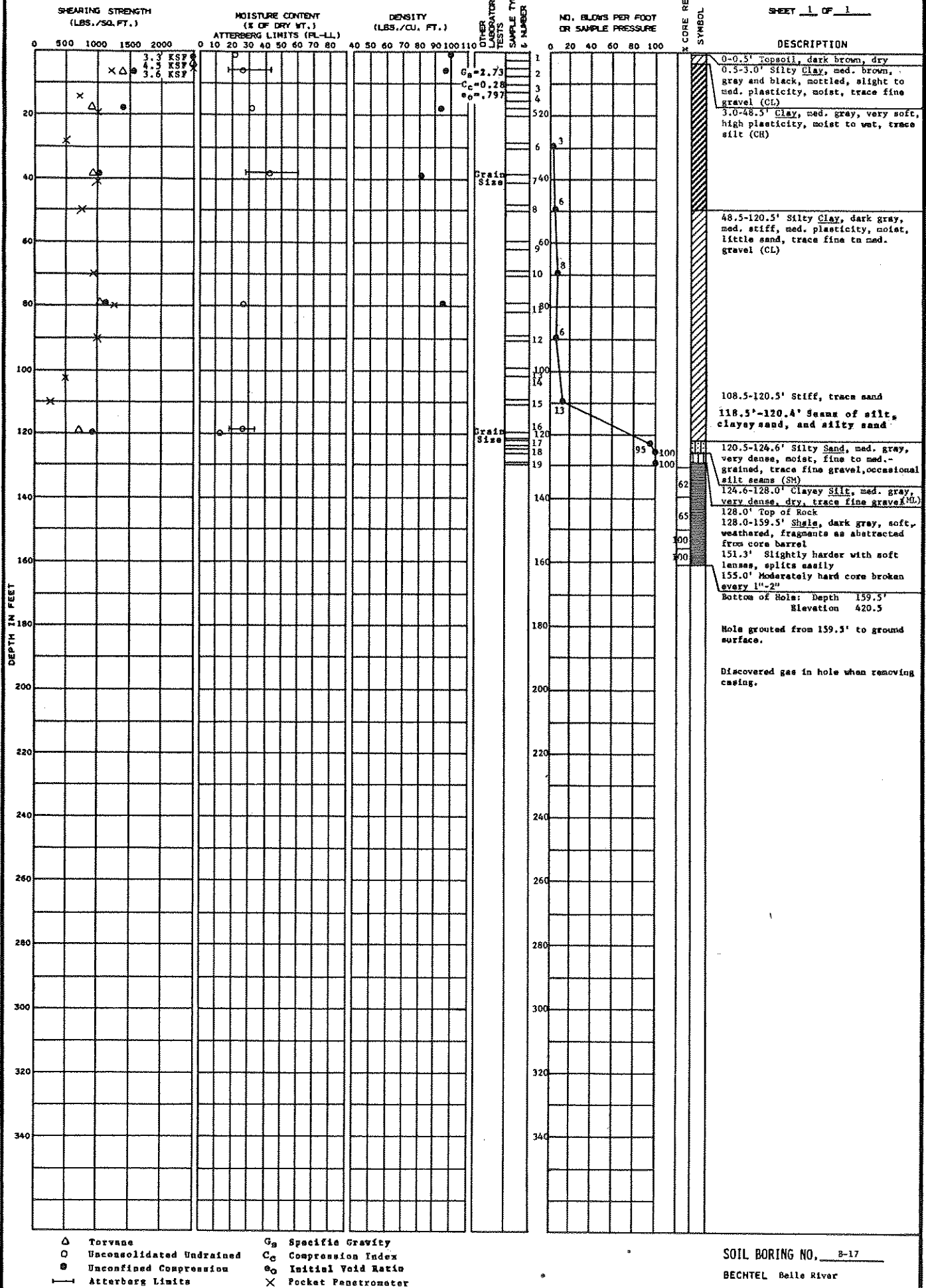
DESCRIPTION

SOIL BORING NO. B-13

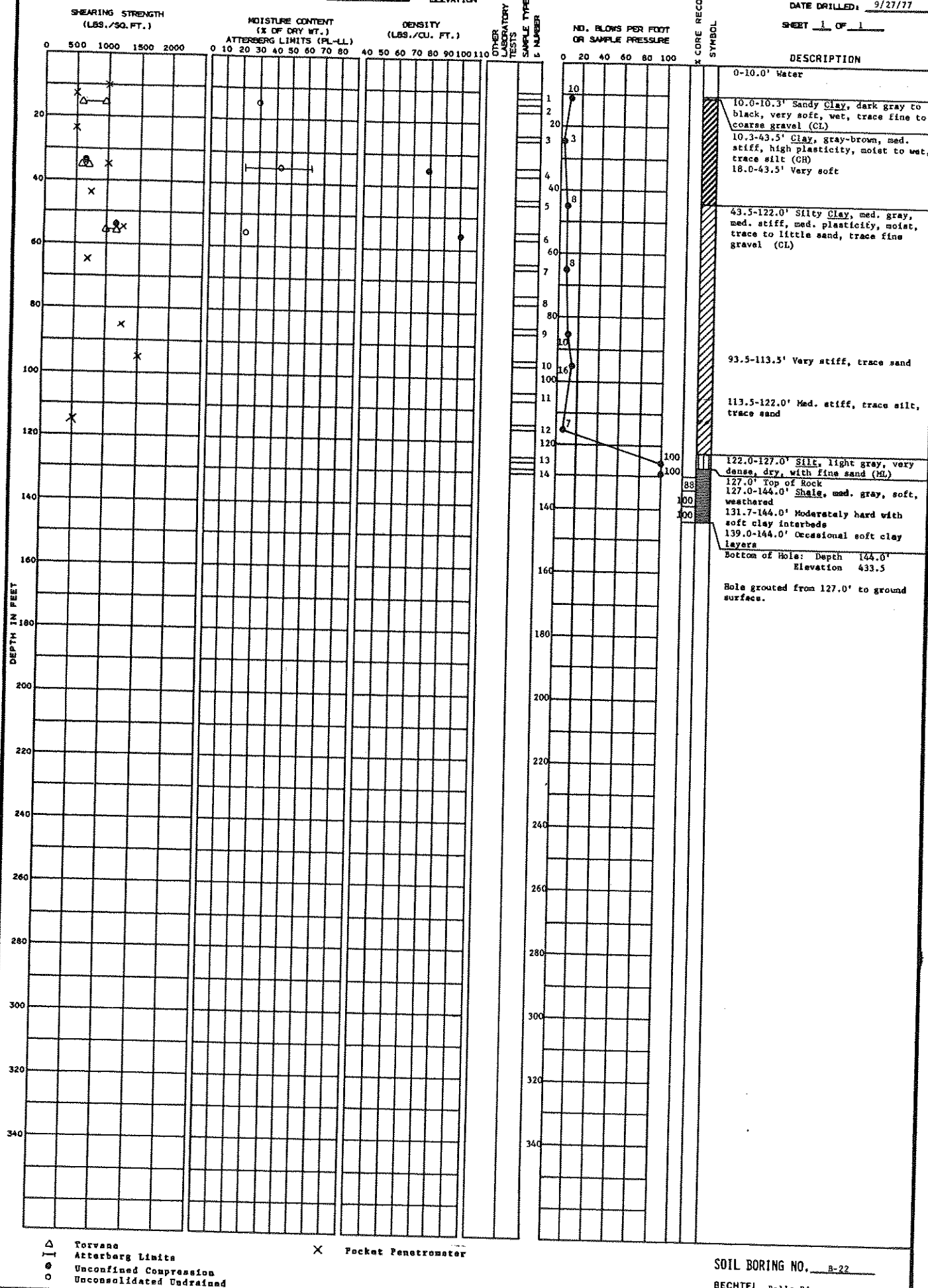
BECHTEL Belle River

DATE DRILLED: 9/7/77
9/14/77

SHEET 1 OF 1

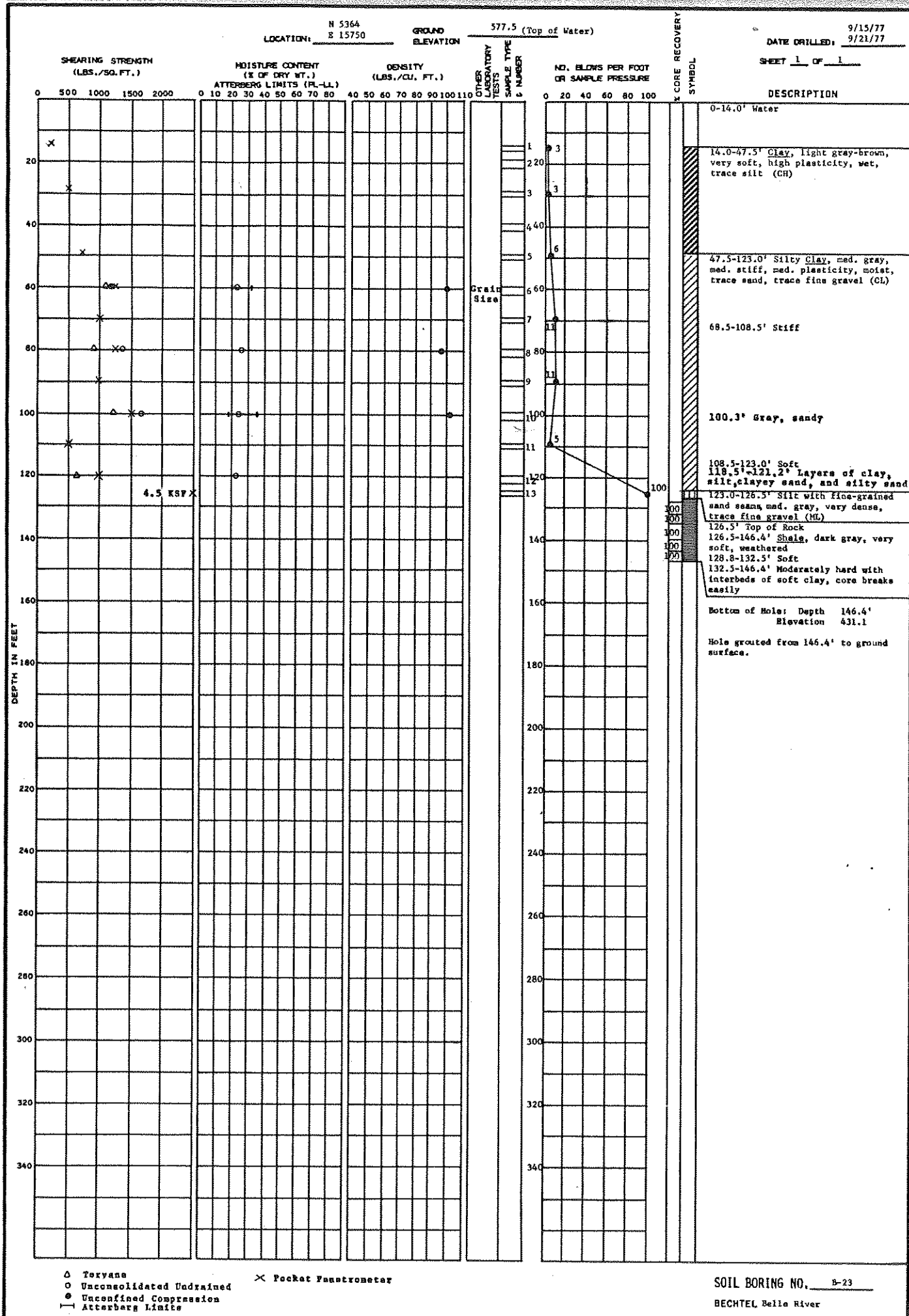


PAGE 1 OF 1



SOIL BORING NO. B-22

BECHTEL Belle River



LOCATION: N 7113
E 11030

GROUND ELEVATION: 588.5

DATE DRILLED: 9/1/77
SHEET 1 OF 1

DEPTH IN FEET	SHEARING STRENGTH (LBS./SQ. FT.)	MOISTURE CONTENT (% OF DRY WT.) ATTENBERG LIMITS (PL-LL)	DENSITY (LBS./CU. FT.)	NO. BLOWS PER FOOT OR SAMPLE PRESSURE	DESCRIPTION
	0 500 1000 1500 2000	0 10 20 30 40 50 60 70 80	40 50 60 70 80 90 100 110	0 20 40 60 80 100	
0				12	0-0.8' Topsoil, dk. brown, dry
1				20	0.8-4.0' Clayey Silt, yellow to med. brown, med. dense, dry, trace sand, trace fine to coarse gravel, roots (CH)
2				18	
3				15	4.0-17.0' Silty Clay, dk. brown and gray, mottled, med. stiff to very stiff, med. plasticity, moist, trace sand, trace fine to coarse gravel (CL)
4				14	9.0' Med. brown
5				13	13.5' Red, GRAY
6				12	17.0-30.0' Clay, med. gray, soft, high plasticity, moist to wet, trace silt, trace sand, trace fine gravel (CH)
7				11	Bottom of Hole: Depth 30.0'
8				10	Elevation 588.5
20					
40					
60					
80					
100					
120					
140					
160					
180					
200					
220					
240					
260					
280					
300					
320					
340					

SOIL BORING NO. B-24
BECHTEL Belle River

LOCATION: H 6921 Z 11501		GROUND ELEVATION 587.5		DATE DRILLED: 9/1/77	
SHEET 1 OF 1					
SHEARING STRENGTH (LBS./SQ. FT.)		MOISTURE CONTENT (% OF DRY WT.) ATTERBERG LIMITS (PL-LL)		DENSITY (LBS./CU. FT.)	
0 500 1000 1500 2000		0 10 20 30 40 50 60 70 80		40 50 60 70 80 90 100 110	
NO. BLOWS PER FOOT OR SAMPLE PRESSURE		OTHER LABORATORY TESTS		CORE RECOVERY	
0 20 40 60 80 100		SAMPLE TYPE & NUMBER		SYMBOL	
DEPTH IN FEET				DESCRIPTION	
0				0-0.7' Topsoil, dk. brown, dry	
20				0.7-4.5' Silty Sand, tan and yellow, mottled, loose, damp, fine-grained (SM)	
40				4.5-9.0' Silty Clay, brown and gray, mottled, stiff to very stiff, med. plasticity, moist, trace sand, trace fine to coarse gravel (CI)	
60				9.0-30.0' Clay, med. gray, very soft, high plasticity, moist to wet, trace sand, trace fine gravel, trace silt: (CH)	
80				Bottom of Hole: Depth 30.0'	
100				Elevation 557.5	
120				Hole backfilled with cuttings.	
140					
160					
180					
200					
220					
240					
260					
280					
300					
320					
340					

LOCATION: N 6730
E 11963

GROUND
ELEVATION

588.1

DATE DRILLED, 9/1/77

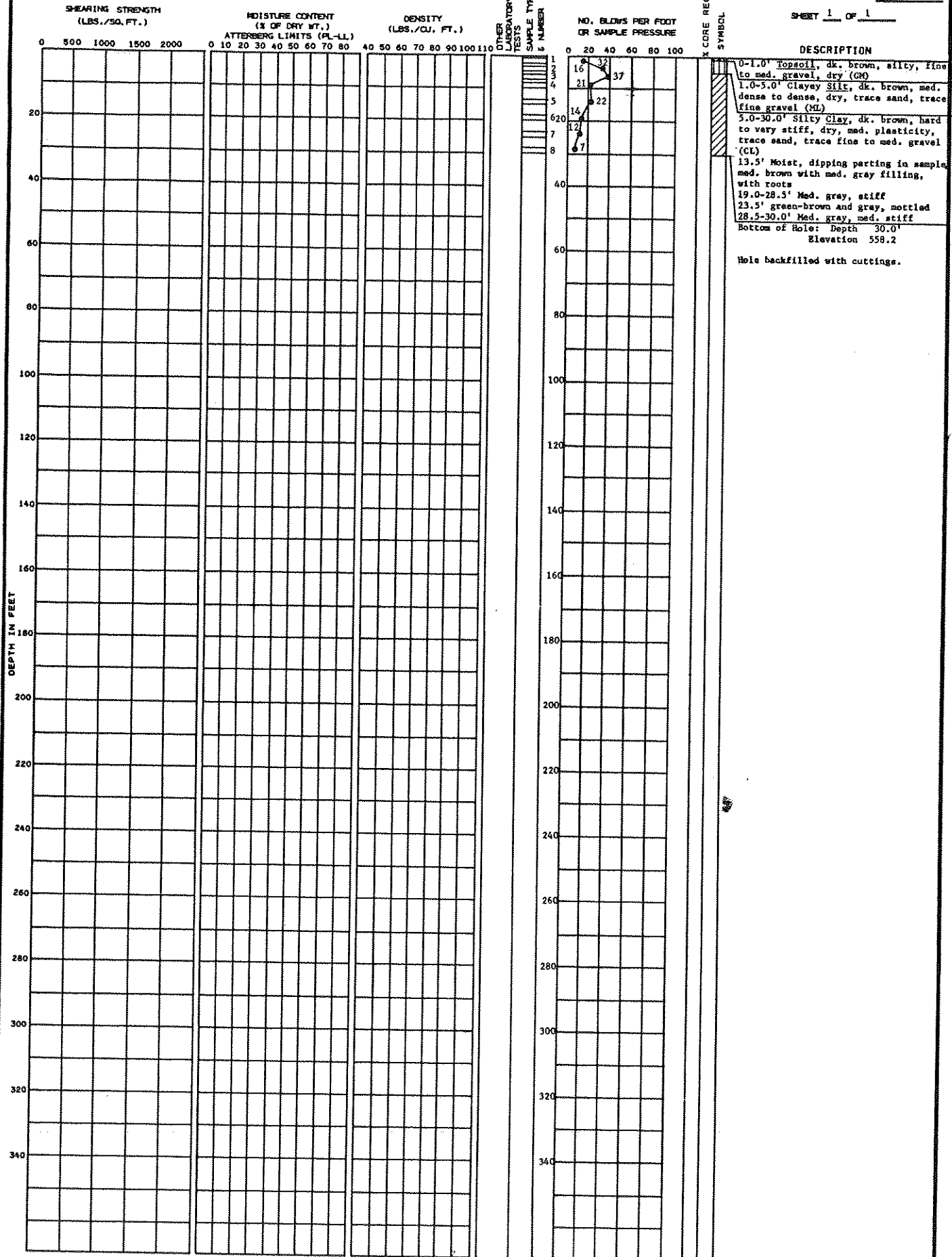
SHEET 1 OF 1

DEPTH IN FEET	SHEARING STRENGTH (LBS./SQ. FT.)	MOISTURE CONTENT (% OF DRY WT.) ATTERBERG LIMITS (PL-LL)	DENSITY (LBS./CU. FT.)	NO. BLOWS PER FOOT OR SAMPLE PRESSURE	CORE RECOVERY SYMBOL	DESCRIPTION
0						0-0.7' Topsoil, dr. brown, dry
0.7						0.7-4.0' Silty Sand, tan and gold, mottled, med. dense, dry, fine- grained, roots (SM)
4.0						4.0-13.5' Silty Clay, gray and brown, mottled, med. stiff to very stiff, med. plasticity, moist, trace sand, trace fine gravel (CL)
13.5						6.0' Green brown
13.5-30.0						13.5-30.0' Clay, med. gray, soft, high plasticity, moist to wet, trace silt, trace fine gravel (CH)
30.0						Bottom of Hole: Depth 30.0' Elevation 588.1
						Hole backfilled with cuttings.

LOCATION: N 6539 E 12425 GROUND ELEVATION 588.2

DATE DRILLED: 9/2/77
9/2/77

SHEET 1 OF 1

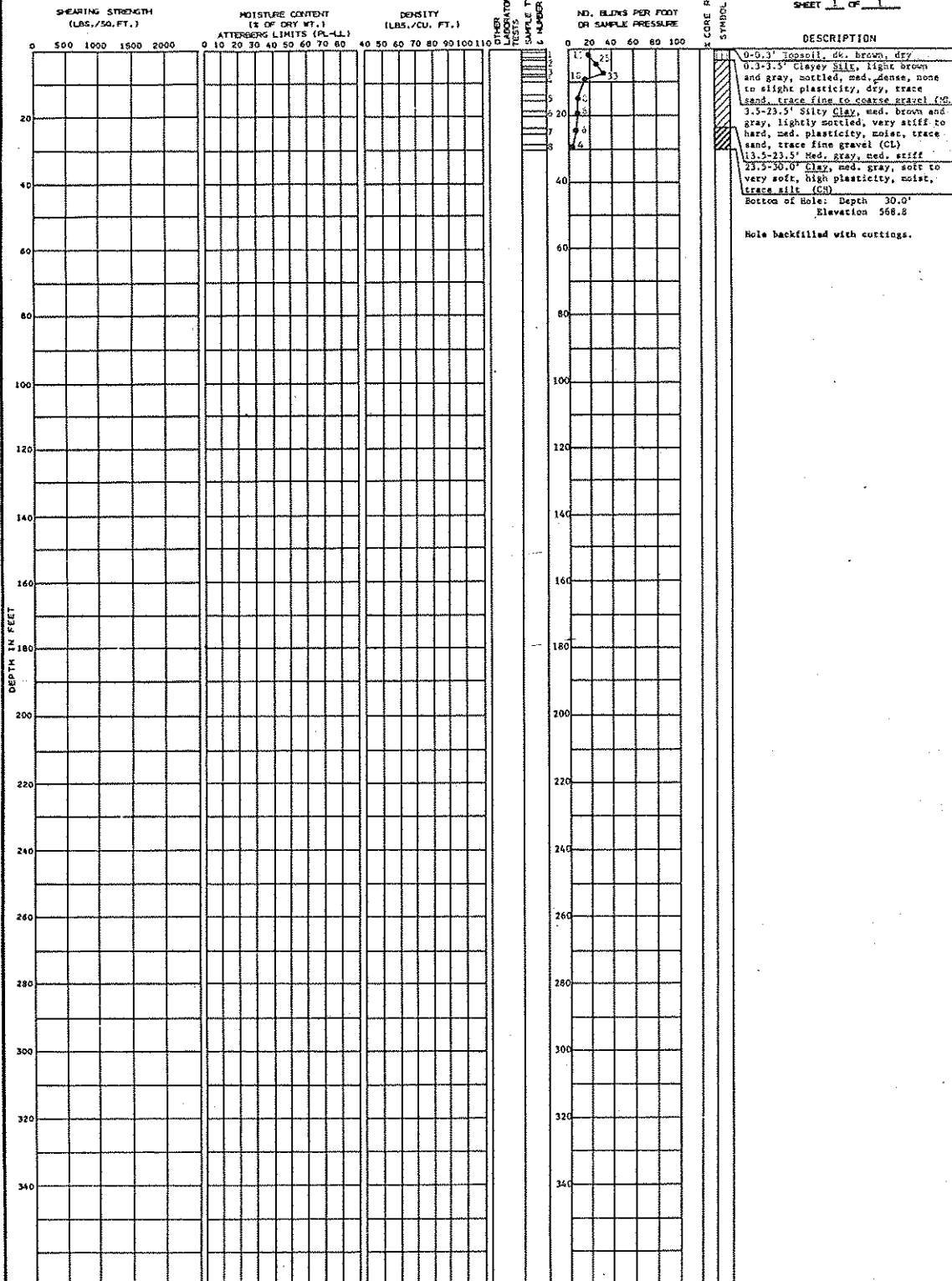


LOCATION: N 6156
E 13309

GROUND ELEVATION 528.8

DATE DRILLED: 9/2/77
9/2/77

SHEET 1 OF 1



SOIL BORING NO. B-34
BECHTEL Belle River

LOCATION: N 50.5
W 12.11

GROUND ELEVATION: 561.5

DATE DRILLED: 9/2/77
9/2/77

SHEET 1 OF 1

DEPTH IN FEET	SHEAR STRENGTH (LBS./SQ. FT.)	MOISTURE CONTENT (% OF DRY WT.) ATTERBERG LIMITS (PL-LL)	DENSITY (LBS./CU. FT.)	NO. OF BLOWS PER FOOT OR SAMPLE PRESSURE	CORE RECOVERY SYMBOL	DESCRIPTION
0						0-0.4' Topsoil, dk. brown, dry
0.4						0.4-16.0' Silty clay, dk. brown and gray, mottled, very stiff to med. stiff, slight plasticity, moist, trace sand, trace fine gravel (CL)
16.0						3.5-5.0' Scattered stringers of calcium carbonate
5.0						8.5-14.0' Med. brown
14.0						14.0-30.0' Clay, med. gray, soft to very soft, high plasticity, moist, trace silt (CH)
30.0						Bottom of Hole: Depth 30.0' Elevation 561.5
						Hole backfilled with cuttings.

SOIL BORING NO. B-36
BECHTEL Belle River

UNNUMBERED

DATE: 9/6/77

LOCATION: H 5774 E 16272 GROUND ELEVATION: 591.2

DATE DRILLED: 9/6/77

SHEET 1 OF 1

DEPTH IN FEET

SHEARING STRENGTH (LBS./SQ. FT.)

MOISTURE CONTENT (% OF DRY WT.)

ATTERBERG LIMITS (PL-LL)

DENSITY (LBS./CU. FT.)

NO. BLOWS PER FOOT OR SAMPLE PRESSURE

LABORATORY TESTS

SAMPLE TYPE

CORE RECOVERY

SYMBOL

DESCRIPTION

0-0.3' Topsoil, dk. brown, moist

0.3-13.5' Silty clay, med. brown and gray, mottled, med. stiff, med. plasticity, trace sand, trace fine gravel (CL)

6.0-8.5' Med. brown, very stiff

8.5-13.5' Med. brown, stiff

13.5-30.0' Clay, med. gray, med. stiff, high plasticity, moist, trace silt (OH)

33.5-38.5' Very soft, moist to wet

38.5-39.0' Soft

Bottom of Hole: Depth 39.0'

Elevation 561.2

Hole backfilled with cuttings.

SOIL BORING NO. B-38

BECHTEL Belle River

LOCATION: N 5532
S 14735

GROUND ELEVATION: 560.2

DATE DRILLED: 9/8/77
9/8/77

SHEET 1 OF 1

DEPTH IN FEET	SHEARING STRENGTH (LBS./SQ. FT.)	MOISTURE CONTENT (% OF DRY WT.) ATTERBERG LIMITS (PL-LL)	DENSITY (LBS./CU. FT.)	LABORATORY TESTS	NO. BLOWS PER FOOT ON SAMPLE PRESSURE	CORE RECOVERY	SYMBOL	DESCRIPTION
	0	0 500 1000 1500 2000	0 10 20 30 40 50 60 70 80	40 50 60 70 80 90 100 110	1 2 3 4 5 6 7 8	0 20 40 60 80 100		
20					21			0.4-13.5' Silty clay, med. brown, med. stiff to very stiff, med. plasticity, moist, trace sand, trace fine gravel (CL)
40								13.5-30.0' Clay, med. gray, soft to very soft, high plasticity, moist to wet, trace silt (CH)
60								Bottom of Hole: Depth 30.0' Elevation 560.2
80								Hole backfilled with cuttings.
100								
120								
140								
160								
180								
200								
220								
240								
260								
280								
300								
320								
340								

SOIL BORING NO. E-50

BECHTEL Belle River

LOCATION: N 5355 E 15258		GROUND ELEVATION: 559.9		DATE DRILLED: 9/6/77		SHEET 1 OF 1	
SHEARING STRENGTH (LBS./SQ. FT.)		MOISTURE CONTENT (% OF DRY WT.) ATTERBERG LIMITS (PL-LL)		DENSITY (LBS./CU. FT.)		NO. BLOWS PER FOOT OR SAMPLE PRESSURE	
0 500 1000 1500 2000		0 10 20 30 40 50 60 70 80		40 50 60 70 80 90 100 110		0 20 40 60 80 100	
DEPTH IN FEET		0		0		176	
						176	
20		20		20		0-0.3' Topsoil, dk. brown, dry	
						0-0.3' Topsoil, dk. brown, dry	
40		40		40		0.3-4.0' Clayey Silt, light brown, med. dense, dry, trace sand, trace fine to coarse gravel (GL)	
						0.3-4.0' Clayey Silt, light brown, med. dense, dry, trace sand, trace fine to coarse gravel (GL)	
60		60		60		4.0-18.5' Silty Clay, med. brown and gray, mottled, very stiff, med. plasticity, moist, trace sand, trace fine gravel (CL)	
						4.0-18.5' Silty Clay, med. brown and gray, mottled, very stiff, med. plasticity, moist, trace sand, trace fine gravel (CL)	
80		80		80		8.5-18.5' Med. stiff	
						8.5-18.5' Med. stiff	
100		100		100		18.5-30.0' Clay, med. gray, very soft, high plasticity, moist to wet, trace silt (CH)	
						18.5-30.0' Clay, med. gray, very soft, high plasticity, moist to wet, trace silt (CH)	
120		120		120		28.5-30.0' Soft	
						28.5-30.0' Soft	
140		140		140		Bottom of Hole: Depth 30.0'	
						Bottom of Hole: Depth 30.0'	
160		160		160		Elevation 559.9	
						Elevation 559.9	
180		180		180		Hole backfilled with cuttings.	
						Hole backfilled with cuttings.	
200		200		200			
220		220		220			
240		240		240			
260		260		260			
280		280		280			
300		300		300			
320		320		320			
340		340		340			

SOIL BORING NO. 2-42

BECHTEL, Santa River